### **HUMAN MARS MISSION**

### Launch Window from Earth Orbit

### FINAL REPORT

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Submitted to:
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### Human Mars Mission Launch Window from Earth Orbit Introduction

The determination of orbital window characteristics is of major importance in the analysis of human interplanetary missions and systems. The orbital launch window characteristics are directly involved in the selection of mission trajectories, the development of orbit operational concepts, and the design of orbital launch systems The orbital launch window problem arises because of the dynamic nature of the relative geometry between outgoing outgoing escape asymptote is contained by the plane of parking orbit. Even though this condition may be planned as a and, therefore, a  $\Delta V$  penalty. Usually, because of the  $\Delta V$  penalty the actual departure injection window is smaller in Earth's oblateness. Thus, a coplanar injection onto the escape hyperbola can be made only at a point in time when the hyperbola asymptotic relative to earth is a function of time. The required hyperbola energy level also varies with time In addition, the inertial orientation of the parking orbit is a function of time because of the perturbations caused by the nominal situation, it will not generally represent the more probable injection geometry. The general case of an escape injection maneuver performed at a time other than the coplanar time will involve both a path angle and plane change (departure) asymptote of the hyperbolic escape trajectory and the earth parking orbit. The orientation of the escape duration than that determined by energy requirement alone

This report contains the formulation, characteristics, and test cases for five different launch window modes for Earth orbit

These modes are:

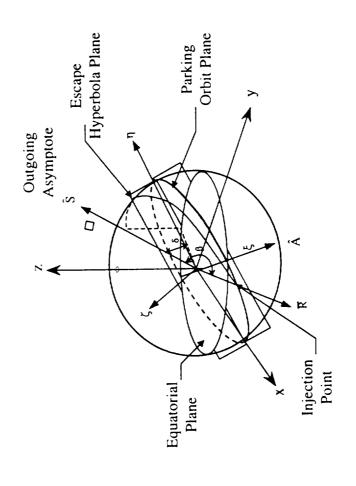
- (1) One impulsive maneuver from a Highly Elliptical Orbit (HEO)
- (2) Two impulsive maneuvers from a Highly Elliptical Orbit (HEO)
  - (3) One impulsive maneuver from a Low Earth Orbit (LEO)
    - (4) Two impulsive maneuvers from LEO
- (5) Three impulsive maneuvers from LEO

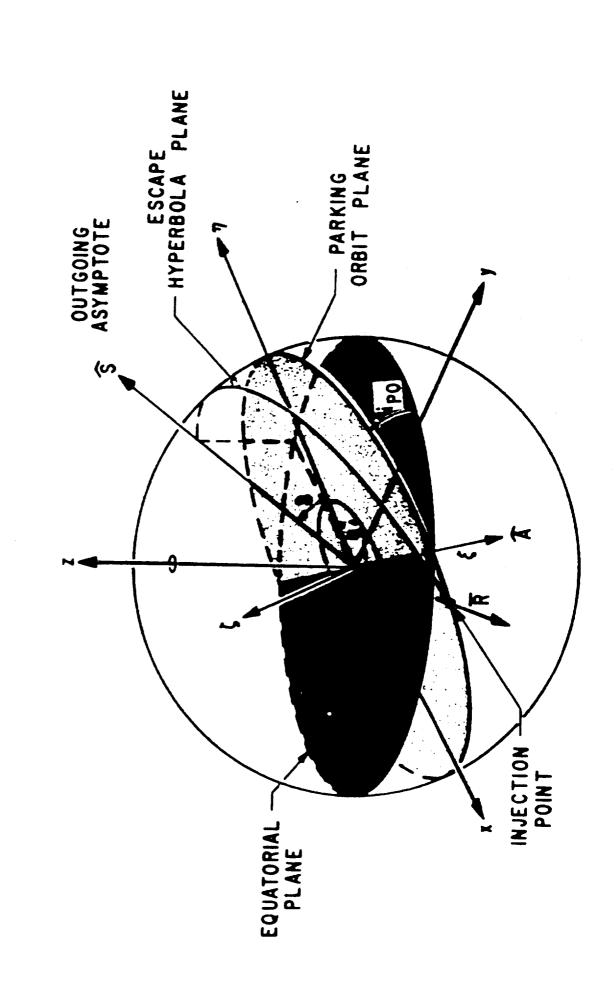
parametric data for space exploration studies. Also the formulation provides vector and geometrical data sufficient for use as a good starting point in detail trajectory analysis based on calculus of variations, steepest descent, or parameter The formulation of these five different launch window modes provides a rapid means of generating realistic optimization program techniques

### NON-COPLANAR ORBITAL LAUNCII GEOMETRY

I degree per day. Because of the LEO regression rate, co-planar launch geometry exists for only a short period of time The basic geometry of the completely general, non-coplanar orbital launch geometry is illustrated in this chart. The escape energy per unit mass). The parking orbit ascending node has a regression rate of -5.0 to -7.2 degrees per day for Low Earth Orbit (LEO) The angular orientation ( $\alpha$  and  $\delta$ ) of the outgoing asymptote changes much slower, less than defined by the outgoing asymptote vector  $(\overline{S})$  right ascension  $(\alpha)$  declination  $(\delta)$  and  $C_3$  (twice the total hyperbolic parking orbit plane is defined by orbit inclination and orbit ascending node. The escape hyperbolic conditions are

per day. The required plane change between the HEO and the outgoing asymptote does not build up as fast as in the High Earth Orbit (HEO) (orbit period ~24 hour) ascending node regression rate is much smaller, ~ -0.10 degree LEO case. The HEO conditions would exist for the SEP architecture. And the LEO conditions would exist for the nuclear thermal and chemical high thrust architectures





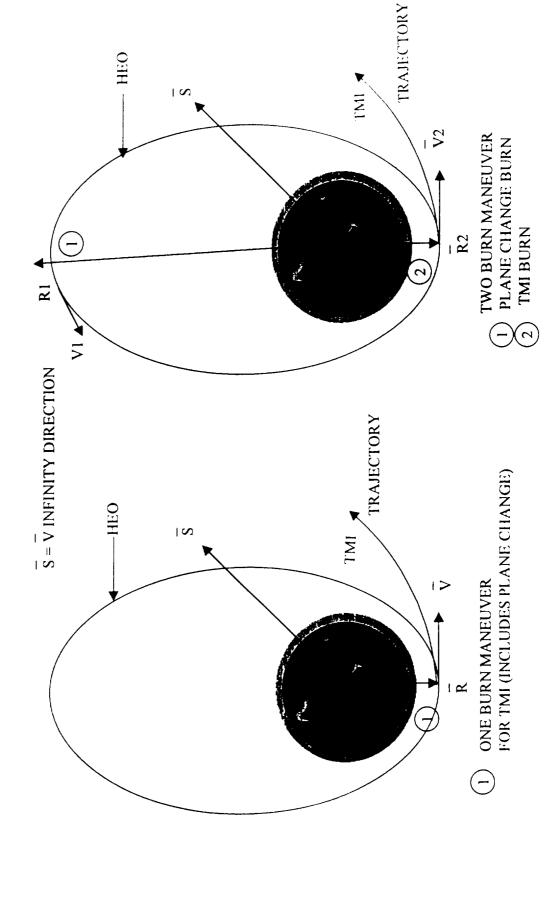
## LAUNCH WINDOW FROM A HIGH ELLIPTICAL ORBIT (HEO)

The duration of a planetary launch window depends on the orbital dynamic change between the orbit plane and The parameters that affect the orbital launch window include the parking orbit inclination, perigee altitude, apogee outgoing asymptote vector (S) and the hyperbolic energy level required for the earth's Trans-Mars injection (TMI) altitude, and the declination and right ascension of the outgoing asymptote vector (S)

requirement can be prohibitively large. Thus a more efficient means of attaining TMI is desired. This can be achieved the TMI may be made efficiently with a single burn maneuver. The single burn maneuver will include an orbit energy High Elliptical Orbit (HEO). When the angle between the orbit plane and the outgoing asymptote vector (S) is small, which change the HEO plane to contain the outgoing asymptote vector, creating an inplane maneuver for the second This chart shows the orbital geometry for a one burn maneuver and a two burn maneuver to achieve TMI from a by dividing the TMI maneuver into two burns. The first burn maneuver is made near the HEO apogee, at point (1) change combined with a plane change. When the angle between the orbit plane and S is large, however, the  $\Delta v$ burn near HEO perigee, at point (2) to complete TMI

Both the single burn maneuver and two burn maneuver results need to be determined across the duration of the launch window to identify which is the more efficient on a given day

### LAUNCH WINDOW FROM A HIGH ELLIPTICAL ORBIT (HEO)

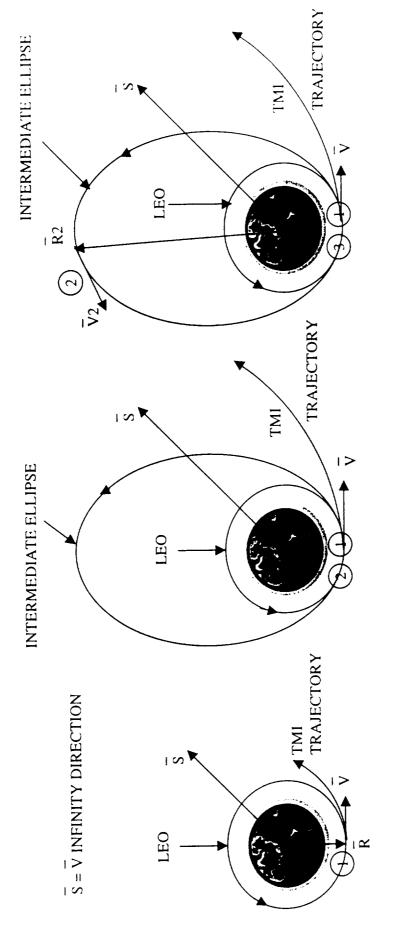


### LAUNCH WINDOW FROM LOW EARTH ORBIT (LEO)

This chart shows the orbital geometry for a one, two and three burn maneuver to achieve Trans-Mars Injection (TMI). ourn maneuver because the gravity loss would be considerably lower. The first burn would place the Mars' vehicle into an intermediate ellipse (~4.8 hr period) where the vehicle would coast one orbit back near perigee (at point (2)). At this  $low (\leq 0.25)$  and the required plane change is  $low (\leq 3.0^{\circ})$  the two burn maneuver would be more efficient than the one The one burn maneuver, which includes an orbit energy change combined with a plane change, is made near the LEO perigee. When the thrust to initial weight ratio is relatively high  $(\ge 0.6)$  and the required plane change angle is small ≤ 3.0°) the one burn maneuver would be efficient to achieve TMI. When the thrust to initial weight ratio is relative point the second burn is made which includes an orbit energy change and a plane change to achieve TMI.

to change the intermediate orbit plane to contain the outgoing asymptote vector (S<sup>-</sup>). After the second burn the vehicle ellipse (~4.8 hr period). The vehicle coasts to just past apogee of the intermediate ellipse where a second burn is made The three burn maneuver for TMI may be more efficient when the thrust to initial weight ratio is low ( $\leq 0.25$ ) and the required plane change is greater than three degrees. The first burn places the Mars vehicle into an intermediate coasts back to near perigee where the third burn, inplane, maneuver is made to achieve TMI. The results from all three different types of burn maneuvers need to be determined across the duration of the launch window to identify which is the most efficient on a given day.

# LAUNCH WINDOW FROM LOW EARTH ORBIT (LEO)



(1) ONE BURN MANEUVER FOR TMI (INCLUDES PLANE CHANGE)

- TWO BURN MANEUVER

  BURN INTO INTERMEDIATE

  ELLIPSE (~ 4.8 HR PERIOD)
- (2) TMI BURN (INCLUDES PLANE CHANGE)
- THREE BURN MANEUVER

  (1) BURN INTO INTERMEDIATE

  ELLIPSE (~ 4.8 HR PERIOD)
  - (2) PLANE CHAGE BURN (3) TMI BURN

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Vinf (km/sec) Eff Delta-V (km/sec) Vel Losses (m/sec) Propellant (kg or t) Burn time (hr) Thrust (lbs or klbs) Spec Imp (sec) Mass Changes (kg or t)

Dry Stage Jettisoned

Probes Separated

Orop Mass Left Grop mass Left Sample Mass Added

AeroBrake Separated

PERFORMANCE COMMAR: 15 10 1 per 1 Plint Come Arrive g Stay Time Separt 117. 1177 Mars 700.21. 2014, 14.20.0 rours RMT (2011an late (364e)) JAN 4, 2014, 12.0000 hours GMT Julian Date 56662.0000 Earth 770 →, 2016, 18.110# obars 9M7 7111an Date | \$1579.1541 Barth JAN 1, 2016, 18.1008 hours GMT Julian Date 57389.2542 528 9540 Macs Total Diration (17.200) SPACECRAFT MASS SUMMARY (kg or t 100.837 6.000 18.520 0.000 0.000 0.000 0.000 0.600 17.312 13.100 0.000 0.000 45.305 6.300 9.245 0.000 0.000 0.000 0.000 0.600 23.560 0.000 0.000 0.000 DEPARTURE/ARRIVAL CONDITIONS V Inf Decl Rt Asc Brn Tm Del V Vinss (km/s) (deg) (deg) (min) (km/s r s 5.45214 -7.24 314.24 0.000 0.00002 0.000 ----- Depart -----V Inf Decl Rt Asc Brn Tm Del V VLoss (km/s) (deg) (deg) (min) (km/s) (m/s) 3.11432 -8.92 168.66 12.741 0.92216 13.062 2.79973 22.29 160.17 6.068 0.97502 2.970 Leg (km/s) (deg) (deg) (min) 5.45214 -7.24 314.24 3.000 6.81300 15.54 84.03 0.000 HELIOCENTRIC TRANSFER ORBIT ELEMENTS Arrival Semi-Axis Eccentricity Inclination Asc Node Arg Per True Anom True Anom Perihelion Aphelion Period Departure 
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 LAUNCH DELTA V ORIENTATION - PLANETOCENTRIC Altitude Inclination Delta V Declination Rt Ascension X Dot Y Dot Z Dot (km) (deg) (km/sec) (deg) (deg) (km/sec) 300.00000 51.60000 0.92216 47.33333 116.49330 -0.27880 0.55935 -0.67807 0.52809 MISSION OPERATIONS Earth Mars Earth Dep Helio Arr Dep Helio Arr Earth Earth 0.30 198.30 727.25 917.25 198.30 528.95 190.30 Times (days) Jepart/Arrive Flight/Stay Esc/Cap Orbits (radii) 12.09 0.00 10.95 1.13 0.00 1.07 0.00 Apoapse Distance Periapse Distance 1.6574 0.0000 None Vloss None
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(AU)	icity Inclination Asc Node Arg Pe (deg) (deg) (deg) 71418 1.03452 289.88018 163.315 71051 1.65105 107.77942 232.399	.43 16.77637 157.16907 0.975806	
	LAUNCH DELTA V ORIENTA	TION - PLANETOCENTRIC	
Altitude (km) 300.00000 900.00000	(deg: (km/sec) (deg: 0 51.60000 0.98372 -44.40399	(deg) (km/sec) (km/sec) 118,99913 -0.34071 0.61468	(km/sec)
	MISSION C	PERATIONS	
	Earth Mars Dep Helio Arr Dep Heli	Earth o Arr	
.nes days. Depart/Arrive Flight/Stay	0.00 192.60 721.25 192.60 528.65 190.0	911.25	
.;; Cap Orbits (radii) Appapse Distance Pariapse Distance	12.09 0.00 10.95 1.13 0.00 1.07	0.00	
Inspectaft Distances (AU) Minimum Heliocentric Maximum Heliocentric Geocentric	0.9834 1.018 1.5000 1.1266 1.6764		
	Vloss         None         Vloss           3.31         5.45         2.80           0.98         0.00         0.00         0.98         0.0           16.22         0.00         2.97         0.297         0.297         0.297         0.23         0.00         0.10         0.10         0.10         0.475         0.00         0.475         0.00         0.42.1         0.00         0.42.1         0.00         <	None 6.81 00 0.00 0.00 0.00 0.00 0.00 0.00	
Mass Changes (kg or t) Dry Stage Jettisoned Probes Separated AecoBrake Separated Ocho Mass Left Jampin Mass Added	6.00 0.00 6.30 17.31 13.10 0.00 0.00	0.00 23.56 0.00 0.00 0.00	

### PERECRMANCE COMMAND

	ng Tumer Baya	(нрас*						Arr	, yo					.ari Time Isy
		Sicto	ľΑ	n II. 20 Jul		. 1000 nou te - 5661		Mac	i	770 20, 2 30	lvi4,	. 1.01 .ndn3.	. 1847 	
	าย.ศ541	Mara	JA			.0390 nou	irs GMT 89.2541	Ear*	t.n	701. 3. 3 70	1)16, 18.0 111an Date	∮್ಳ ದರ್ಭಕ್ ಕನ್ನಿತ∗.		. •
											7	ota. Cira	tion	< + _ 41
							T MASS ST		kg or ti					
Seg	Initial	Engine	Depart Propell	Tankag	e E:	ngine Pi	ropell T	ankage			AeroBrk			
1	102.859 45.905	5.300 6.300	20.542 9.245	0.00	0 0	0.000 0.000		0.000	0.600 0.600	17.312 23.560	13.100		0.000	
							RE/ARRIVA							
Leg 1 2	V (kr	Inf De m/s) (de 0356 -4.9973 22.	cl Rt g) (d 10 164	Asc Br (eg) ( .99 14	n Tm min) .132	Del V (km/s) 1.01242	VLOSS (m/s) 17.872		V Inf (km/s) 5 45055	Decl (deg) -8.27	Rt Asc (deg) 314.28 84.03	Brn Tm (min) 0.000	Del V (km/s) 0.00000	71238 m/s 0.000
					HEL:	IOCENTRIC	C TRANSFE	R ORBIT	ELEMENT	S				
.÷q	Semi-Axis (AU) 1.2536313 1.3029498	0 22321	1351	(deg) 0.99241	291	deg) .91572	(deg) 161.1784	True (0 4 18	e Anom deg) .91564	157.27082	n Perihe. (AU	065 1.5	ohelion (AU) 0334560 0780313	
					LAUNCH		ORIENTAT							
		Altitude (km) 800.00000 800.00000	(d 51.	60000	(km/sed	c) 42 -43	(deg)	(d) 119.	eg) 91316	(km/sec)	Y Dot (km/sec) 0.63862 0.66289	(KM/Se	(38	
						M:	ISSION OF	ERATION:	5					
_	and a second		Earth Dep	Helio		ars Dep	p Helio	Earth Arr						
Cepa	(days) rt/Arrive ht/Stay		0.00	19 .90.60	0.60 52	719.: 8.65	25 190.00	909.25						
Apoa	p Orbits pse Distan apse Dista	ce	12.09		0.00	10.		0.00						
Mini Maxi	raft Dista: mum Helioc mum Helioc entric	entric		).9835 5000	1266	1.67	1.0166 1.6574 64							
Vinf Eff Vel Prop Burn Thru	ers  wilsion Typ    (km/sec)  Delta-V (k/ Losses (m/ wellant (kg    time (hr) ist (lbs or    Imp (sec)	m/sech sech or the	17.97	0.00	None 5.45 0.00 0.00 0.00 0.00 0.00 0.00	0. 2.	80 98 0.00 97 25 0.00 10 75	0.00						
Ory Prob Aero Orop	changes (kg Stage Jett es Separat Brake Sepa Mass Left le Mass Ad	isoned ed rated	6.00		1	6. 7.31 3.10 0.00 0.00	30	0.00 23.56 0.00 0.00 0.00						

Hass Changes (kg or t) Dry Stage Jettisoned Probes Separated AeroBrake Separated Drop Mass Left Jample Mass Added

		er pert					PEPE	C.PMAIRCE	ARMSTT.	:					
	a, Time dayo:	Separ	<b>-</b> .						Arr	, yo					. Programme of the control of the co
		Sarto		JAN 13,		12.000 Date			Mar	3	770 30, c	an Cate	di o to us Shahd	- 187 . 6	
٠.	. 4, e1 11	Масл		JAN 1,		18.008 Sate			Ear	th	772 9, I	olso idol Llar Dase	988 0015 31319		. • _ ′
					, 111.		, , , , ,						otal Sur		1.4 . 1.
						SPACE	CRAFT	MASS 3U	MMARY (	kg or t)					
Seg	Initial	Engine	- Depar Prope	t 11 Tani	cage	Engin	Arr e Pro	ive pell T	ankage	Inert	Proces	AeroBrk	Drops	Samples	NetMass
1	103.222	6.000 6.300			.000	0.00	-	0.000	0.000	0.600 0.600		13.100 0.000	0.000 0.000	0.000 0.000	48.308 6.200
						DEP	ARTURE	:/ARRIVA	L CONDI	TIONS					
Leg : 2	(ka 3.4		ecl R eg) .58 1	Depai t Asc (deg) 64.61 60.17	Brn Tr (min)	n Di ( <b>k</b> z L 1.0:	el V m/s) 2839	VLoss (m/s) 18.842 2.970		V Inf (km/s) 5.45253	(deg:	Rt Asc (deg) 314.25	Brn Tm (min) 0.000		1233
					i	HELIOCE	NTRIC	TRANSFE	R ORBIT	ELEMENT	:s				
.e.# 1 2	Semi-Axis (AU) 1.2530376 1.3029498	0.2237	22760	Inclinat (deg) 0.97; 1.65;	306 2	(deg)	50 1	Arg Per (deg) .60.0975 :32.3998	Tru ( 5 19	e Anom deg)	Arrival True Anom (deg) 157.33408 307.54153	Perihe (AU 0.9727	) 046 1.5	ohelion (AU) 5333701 5790314	Reclod days 510.32388 543.03778
					LAU	CH DEL				LANETOCE					
		Altitude (km) 900.0000 900.0000	0 5	lination (deg) 1.60000 1.60000	(km) 1.0	lta V /sec) 02839 02839	(d -42.	nation leg) 73784 42331	120.	eg) 37302	X Dot (km/sec) -0.38191 -0.46178		(km/se	ec) 191	
							MIS	SION OP	ERATION	S					
	days) t/Arrive t/Stay		Earth Dep 0.30	Helio		,			Earth Arr 908.25						
Apoap	o Orbits ( ose Distan opse Dista	ce	12.09		0.00		10.95		0.00 0.00						
Minim Maxim	aft Dista um Helioc um Helioc entric	entric	0.0000	0.9835 1.5000	1.1266	5	1.6764	1.0166 1.6574							
Vinf Eff D Vel L Prope Burn Thrus	ers  (lsion Type (km/sec) (elta-V (ku .osses (m/ ellant (kg time (hr) tit (lbs or Imp (sec)	m/sec) sec) or t)	Vloss 3.45 1.03 18.84 20.90 0.24 24.75 463.4	0.00	None 5.45 0.00 0.00 0.00 0.00		Vloss 2.80 0.98 2.97 9.25 0.10 24.75 442.1	0.00	0.00						

0.00 23.56 0.00 0.00 0.00

0.00 17.31 13.10 0.00 0.00

6.00

		er 48.4						4,64	-MAN .	. DOMMAR						
	rio Tulter Talib	î.eş	.1f"							Arr	( 7e					int tong laya
		Sar		JAZ		7011, 131.ar			s GMT (.000)	Мас	3		1014, 1.8 ilian Date			i#r ut.
		Was	;	IA:		.die. Sulian				£a:	<b>-</b> 1.	776 ), 1	llis, le.S Llian Date	145 ·	TME :	; • .
													7	ital out	17.15	** *4.
							SPACE	CRAFT	MAJS SU	MMARY (	kg or ti					
584	Initial	Engl	ne Pr	part - opell	Tank	kage	Engin	Arr le Pro	ive pell T	ankage	Inert	Proces	AeroBrk	Drops	Samples	
-	103.608 45.905	6.0 6.3		1.291 9.245		.000	0.00 0.00	10 0	.000 .000	0.000	0.600 0.600		13.100	0.300	3.000	48.308 6.300
							DEP	ARTURE	/ARRIVA	L CONDIT						
	7 (ks 3.5)	Inf m/s) 0288	Decl (deg)	Rt A {de 164.	sc g) 21	Brn Tm (min)	( ) ( ) ( )	el V m/s) (4539	VLoss (m/s) 19.915 2.970		V Inf (km/s) 5.44795	Deci (deg) -8.51	Rt Asc (deg) 314.20	Brn Tm (min) 0.000	0el 7 (km/s. 0.00000	71288 m. s 1.000
÷	٤./	9974	22.29	160.							ELEMENT		•			
. :	Semi-Axis (AU) 1.2521998 1.3029499	0.22	415682	4	(deg) 0.958	ion	Asc No (deg)	de .	Arg Per	Depa True (c 0 21:	arture = Anom dea)	Arrival True Anom (deg) 157.48277	Perihe (AU 0.9715	}	helion (AU) 328889 780314	Period days 511.81011 543.23779
											LANETOCE		V Dot	Z Do		
		Altitu (km) 800.00 800.00	000	(de 51.6	g; 0000		sec) 4539	(d -42.	eg)	120.7	eg) 17749	X Dot (km/sec) -0.39643 -0.46630		(km/se -0.701	c) 88	
								MIS	SION OP	ERATIONS	5					
				rth ep H	elio	Arr	Mars	Dep	Helio	Earth Arr						
	Arrive Stay		3	.30 18	8.70	188.70	528.55	717.25	190.00	907.25						
Apoaps Periap	Orbits (: se Distancese Distan	ce nce	1	.09 .13		0.00		10.95		0.00						
Minimu	ift Distar um Helioce um Helioce utric	entric		1.	9836 4999	1.1273		1.6764	1.0166 1.6574							
Vini / Sit De Val to Scopel Buch t Thrust	sion Type km/sec) (ta-V (kn sses (m/s lant (kg) (ime (hg) (lbs or mp (sec)	n/sec) sec) or t' kibs'	3 19 21 0 24	. 91	0.00	None 5.45 0.00 0.00 0.00 0.00		2.97	0.00	0.00						
lry St Eropes AeroBr Erop M	inges (kg age Jett) Separate ake Sepa: Mass Left Mass Add	isoned ed rated	6	.00		0.00	17.31 13.10 0.00 0.00			0.00 23.56 0.00 0.00 0.00						

02.701		PERFORMANTS	1044/93			
To e enact			ACC178			Mary Mark Tarber Salara
Que to	7AM (b. 2011) 741.am	lu.0000 nours OMT Date - 05671.000	Масо	2011 (2.1. 2011) 2.11 ac	Tara Carraga	1 **
gent i Maro	727 1, 2016, Julian	ls.0981 hours GMT Date 57389.2541	Eactn	700 A. 2016. Julian	[4.])44] 5.9251 GMT Cate   07579.2541	. *
					Dotal Ouration	* 5 2341
		SPACEOPART MASS 30	MMARY (kg or t)			
: Initial Engine	Separt	Arrive Engine Propell T	 ankage Inert	: Probes Aero	:Brk Orops Samp	oles HetMass
. 134 469 6 300		0.000	0.000 0.600		100 0.000 0. 300 0.300 0.	000 45.305 000 6.200
		DEPARTURE/ARRIVA	L CONDITIONS			
Deg Vinf De	19 163.51 15.240	Del V VLOSS (m/s)	V Inf (km/s) 5.44513	Decl Rt A	g) (min) (kn js 0.000 0.00	0000 3:3:4
	н	ELIOCENTRIC TRANSFE	R ORBIT ELEMENT	rs		
y Semi-Axis Eccentri (AU) 1.2505849 0.22522 1.3029499 0.28787	4555 0.92720 2	(deg) 95.98738 156.7575	(deg)	True Anom Pe (deg) 157 72921 0.	erihelion Aphelio (AU) (AU) 9689225 1.53224' 9278683 1.67803	
	LAUN	CH DELTA V ORIENTAT	TION - PLANETOCE	ENTRIC		
Altitude (km) 900.30003 800.30000	(deg) (km/ 51.60000 1.0	sec) (deg)	121.66776	(km/sec) (km/ -0.42901 0.5	Dot Z Dot (sec) (km/sec) 59550 -0.71071 71041 0.66210	
		MISSION OF	PERATIONS			
	Earth Dep Helio Arr	Mars Dep Helio	Earth Arr			
ines days Depart/Arrive Flight/Stay	0.00 186.80 186.80	715.25 523.45 190.00	905.25			
ni Jap Orbits (radii) Appapse Distance Perlapse Distance	12.09 0.00 1.13 0.00	10.95	0.00			
datetraft Distances (AU) Minimum Heliocentric Maximum Heliocentric Geocentric	0.9837 1.4997 0.0000 1.1279	1.016+ 1.6574	0.0000			
Receivers Propulsion Type Vinf (km/sec) Riff Delta-V (km/sec) Vel Losses m/sec' Propullant kg or thairm time (br) Riguet (los or klosher) Rec (mp (sec)	Vloss None 3.61 5.45 1.09 0.00 0.00 22.45 0.00 22.15 0.00 0.00 0.25 0.00 24.75 0.00 463.4 0.00	, 24.73	0.00			

0.00 23.56 0.00 0.00 0.00

0.00 17.31 13.10 0.00 0.00

6.00

6.30

Lis Inanges kg or the style diage lettisoned Schools Separated AeroBrake Separated Scop Mass Left Sample Mass Added

1 11.	erbat 1				•		751.2	7.744					1.
	warth	;			il.vyCy h Date 56			5	775 E., .	oll. The	ist suur Pooleen		. et 1 - e - e - e
*.1.11	Mars	;			18.5976 h		831	th	301 4. 3	:Tib, id." :Lub Date	i Pile nuusi 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	* #5 4.	1.
										7	Stille	t	<pre>* * : *: * : * : * : * : * : * : * : *</pre>
					SPACECRA	FT MASS S	SUMMARY (	kg or ti					
					)						_		
: Initial	-				Engine 1					AeroBrk	•	-	WetMass
108,454		23.13 9.24		.000	0.000	0.000	0.000 0.000	0.600 0.600		13,100	3.300 3.300	3.000	6.200
					DEPARTI	JRE/ARRIN	AT CONDI.	TIONS					
	/ Inf De km/s) (de 73250 -1. 79974 22.	g) (6 35 <b>16</b>	Asc deg)	Brn Tm (min) 15.917 6.068	n Del \ (km/s) 7 1.12562	(m/s 2 25.59	35 37 94	V Inf (km/s) 5.44872	(deg. -8.99	Rt Asc .degi	Brn Tm (min)	Del V (km/s)	
				H	HELIOCENTRI	C TRANSE	FER ORBIT	ELEMENTS	S				
(AU)	0.22652	6914	nclinat (deg) 0.896 1.651	349 2	Asc Node (deg) 198.02269		er True	e Anom deg) .57676	Arrival True Anom (deg) 157.92946 307.54155	UA) 0.9660	) 531 1.5	helion (AU) (319084 (790315	Period   days   509.83781   543.23784
1.3323.	9 U.28(97	1085	1.051	.05		434.377							^
2.3323177	. J.28(9)	1082	1.051		ICH DELTA V			anetoce.	TRIC				$\hat{\Delta}$
2.2323173	Altitude (km) 800.00000	Incli (c 51.	ination deg) .60000	LAUN Del (km/ 1.1	ta V Dec sec) 2562 -3 2562 3	ORIENTA clination (deg) 9.81821 7.74185	TION - PI Rt Asce (de 122.6 124.0	ension eg) (	X Dot (km/sec: -0.46629	Y Dot (km/sec) 0.72804 0.73777	2 Do {km/se -0.720	a: 79 00	A/ 
2.3323173	Altitude (km) 800.00000	Incli (c 51.	ination deg) ,60000	LAUN Del (km/ 1.1	ta V Dec sec) 2562 -3 2562 3	ORIENTA clination (deg) 9.81821 7.74185	TION - PI Rt Asce (de 122.6 124.0	ension (3855 - (1881 -	X Dot (km/sec) -0.46629 -0.49799	(km/sec) 0.72804 0.73777 A	2 Do (km/se -0.720 0.689)	379 00 1/2/4/4/4	A1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
	Altitude (km) 800.00000	Incli (c 51.	ination deg) ,60000	LAUN Del (km/ 1.1	ta V Dec sec) 2562 -3 2562 3	ORIENTA clination (deg) 9.81821 7.74185 NO	ATION - PI 1 Rt Asce (de 122.6 124.0 5 - L	ension (3855 - (1881 -	X Dot (km/sec) -0.46629 -0.49799	(km/sec) 0.72804 0.73777 A	2 Do (km/se -0.720 0.689)	379 00 1/2/4/4/4	A/ 
ces (days) Lapart/Arriva Tight-Stay	Altitude (km) 800.00000 800.00000	Incl: (c 51. 51. Earth Dep	ination deg) .60000 .60000	LAUN Del (km/ 1.1 1.1 1, Arr 184.30	ta V Deciseci 2562 -3 2562 - M	ORIENTA clination (deg) 9.81921 7.74185 NO ISSION O	Rt Asce (de 122.6 124.0	ension (3855 - (1881 -	X Dot (km/sec) -0.46629 -0.49799	(km/sec) 0.72804 0.73777 A	2 Do {km/se -0.720	379 00 1/2/4/4/4	A1 
mes (days) 14part/Arrive	Altitude [km] 800.00000 800.00000	Incl: (c 51. 51. Earth Dep	ination deg) .60000 .60000	LAUN Del (km/ 1.1 1.1 1, Arr 184.30	ta V Dec secil 2562 -3 2562 3 1 C C C M Mars De 713.	ORIENTA clination (deg) 9.81921 7.74185 NO ISSION O P Heli 25 190.0	Rt Asce (de 122.6 124.0	ension (3855 - (1881 -	X Dot (km/sec) -0.46629 -0.49799	(km/sec) 0.72804 0.73777 A	2 Do   km/se	379 00 1/2/4/4/4	A1 
mes (days) lepart/Arrive Tlight/Stay (lap Droits Actapse Distan Periapse Dista apecraft Dista Minimum Helioo	Altitude (km) 800.00000 800.00000	Incl: (6 51. 51. 51. 51. 51. 51. 51. 51. 51. 51.	ination deg) .60000 .60000 Helio 134.30	LAUN Del (km/1.1 1.2 1, Arr 184.80	ta V Dec seci 2562 -3 2562 3 1 C C C M Mars De 713.	ORIENTA clination (deg) 9.81821 7.74185 NO DISSION O P Heli 25 190.0	Rt Asce (de 122.6 124.0	ension (3855 - (1881 -	X Bot (km/sec): -0.46629 -0.49799	(km/sec) 0.72804 0.73777 A 5 V):5 E, 1 A	2 Do (km/se -0.720 0.689)  = -4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4	000 000 000 000 000 000 000 000 000 00	A1 
mea idays; Qedero/Arrive YQughtiStay Actapse Distan Periapse Dista Minimum Helioo Maximum Helioo	Altitude [km] 800.00000 800.00000  radii. de ince ince ince emtric emtric e m. sec: sec: or t. klbs)	Earth Dep 0.000 112.09 1.13 0.0000 Vloss 3.73 1.13 25.59	ination degj .60000 .60000 Helio 134.30 0.9839 1.4997	LAUN Del (km/1.1 1.2 1, Arr 184.80	Tay Decision 1 C C C C M Mars Decision 1 C C C C M M Mars Decision 1 C C C C M M Mars Decision 1 C C C C C C C C C C C C C C C C C C	ORIENTA Clination (deg) 9.81921 7.74185 NO CISSION O P Heli 25 190.0 95 07 1.016 1.657 64 ss 80 98 0.00 97 0.00 75	Rt Asce (de 122.6 124.0 7 - L PERATIONS Earth O Arr 903.25 0 0.00 0.00 None 6.81 0 0.00 0.00 0.00	ension (3855 - (1881 -	X Bot (km/sec): -0.46629 -0.49799	(km/sec) 0.72804 0.73777 A 5 V):5 E, 1 A	2 Do (km/se -0.720 0.689)	000 000 000 000 000 000 000 000 000 00	A1

	- Factor and Communication	, <del>-:</del>					<u> </u>		
1	Merged			PERFORMANCE	SUMMAPY				
- ; Stay Time (days)	Depart	:			Arrive				ght Time (days)
:	Earth		2014, 12.0000 11ian Date		Mars		314, 9.6000 ho Lian Date 568		82.3000
928.3840	Mars		2016, 18.0971 11:an Cate		Earth	JUL 9, 20 Jul	016, 18.0971 ho Lian Date 575		90.0000]
•							Total D	iration 9	01.2540
			SPACECI	raft mass sum	MARY (kg or t)				
leg Initial		- Depart Propell Tank		- Arrive Propell Ta		Probes	AeroBrk Dro	os Samples	NecMass
1 106.569 2 45.905			0.000	0.000	0.000 0.600 0.000 0.600		13.100 0.00 0.000 0.00		45.305 6.200
			DEPA	RTURE/ARRIVAL	. CONDITIONS				
		Depar					Arrive		
1 3.	(km/s) (de	eg) (deg) .59 162.40	Brn Tm De: (min) (km, 16.684 1.17 6.068 0.97	(s) (m/s) 341 29.494	V Inf (km/s) 5.44568 6.81300	(deg) -9.22	Rt Asc Brn Ti (deg) (min 313.76 0.00 84.03 0.00	(km/s) 0.00000	VLoss (m/s. 0.000 0.000
			HELIOCEN'	TRIC TRANSFER	ORBIT ELEMENT	s			
					Departure	Arrival			
Leg Semi-Axi (AU) 1 1.246980 2 1.302950	0.22786		(deg)	(deg) 9 152.22833		True Anom (deg) 158.24099 307.54156		Aphelion (AU) 1.5311234 1.6780316	Period (days) 508.61362 543.23786
			LAUNCH DELTA	a v orientati	on - planetoce	NTRIC			
	Altitude	Inclination				X Dot	Y Dot Z	Dot	
	(km) 900.00000 800.00000	(deg) 51.60000	(km/sec) 1.17341	(deg) -38.61558	(deg) 123.59062	(km/sec)	(km/sec) (km. 0.76374 -0. 0.76829 0.	73231	
			1143.9	MISSION OPE			0,210.	7 1445	ĵ:
		Earth Dep Helio	Mars Arr	Dep Helio	Earth Arr		7175=-	26755	/- <del>/</del> -
Times 'days' Lepart/Arrive	9	0.00		11.25	901.25		C = 1,		
Flight/Stay Esc/Cap Orbits	radiol	182.90	528.35	190.00			7/4:1		
Apoapse Dista Periapse Dist	ance	12.09 1.13		10.95 1.07	0.00 0.00		$\mathcal{K}_{\mathcal{A}_{i}} = \{$	₽Ĉ.¥ -	
Spacecraft Dist		0.9840		1.0166			j	'- ,	
Maximum Helio Geocentric		1.4996	1.1286 1	1.6574	0.0000		4505 1		- / '
Maneuvers Propulsion Ty	/pe	Vloss	None '	Vloss	None			<b>-</b> ',	
Vinf (km/sec) Eff Delta-V	(km/sec)	3.86 1.17 0.00	5.45 0.00	2.80 0.98 0.00	6.81 0.00		-, 677	m - 5.	
Wel Losses (# Propellant (*	(g or t)	29.49 24.25 0.00	0.00 0.00 0.00	2.97 9.25 0.00 0.10	0.00 0.00 0.00		164	<b>.</b> 1	
Burn time .nr Thrust (lbs o Spec Imp (sec	or klbs)	0.28 24.75 463.4	0.00	24.75 442.1	0.00		/ 2 /	16.0	
Mass Changes () Dry Stage Jet	tisoned	6.00	0.00	6.30	0.00			2 9	
Probes Separa AeroBrake Sep Drop Mass Lei	carated		17.31 13.10 0.00		23.56 0.00 0.00		VF = 1	(, 2 5 7 1	
Sample Mass A			0.00		0.00			, , ,	
								2 1	

lur ver jed,

: Stay	Time Dep	art			Arrive		F	light Time (days)
;11c	Sar	th JAI		2.0000 hours GMT ate [56679.0000	Mars	JUL 22, 2014, 3.60 Julian Date		181.3000
9.3 <b>9</b> .	.35:5 Mar	s JA		8.0969 hours GMT ate 57389.2540	Earth	JUL 9, 2016, 18.09 Julian Date	69 hours GMT 57579.2540	190.5000
			Julian D	a.e 3/303.2340			tal Duration	900.2540
				SPACECRAFT MASS S	SUMMARY (kg or t	)		
Leg In		Depart one Propell		Arrive Engine Propell	Tankage Iner	t Probes AeroBrk	Drops Sample	s NetMass
	07.181 6.0 45.905 6.3		0.000 0.000	0.000 0.000 0.000 0.000	0.000 0.60 0.000 0.60		0.000 0.000 0.000 0.000	
				DEPARTURE/ARRIV	VAL CONDITIONS			
Leg 1 2	V Inf (km/s) 3.93042	Decl Rt / (deg) (de -0.24 162 22.29 160	Asc Brn Tm eg) (min) .18 17.105	Del V VLos (km/s) (m/s 1.19944 31.79 0.97502 2.97	ss V I: s) (km/s 93 5.4474	(deg) (deg) 7 -9.34 313.66	e	) m/s, 0.000
			нЕ	LIOCENTRIC TRANSE				
1 1.		8639907	(deg) 0.85877 30	sc Node Arg Pe (deg) (deg) 1.07552 151.081 7.77946 232.399	(deg) 183 29.01679	Arrival True Anom Perihel (deg) (AU) 158.37017 0.96111 307.54156 0.92796	89 1.5308921	Period (days: 508.01713 543.23789
	Altitu (km) 900.00 800.00	(de 1000 51.1	nation Delt eg) (km/s 60000 1.19	ec) (deg) 944 -38.00544 944 37.62524 67.64 /Vo 5	n Rt Ascension (deg) 124.10285 124.33308	X Dot Y Dot (km/sec) (km/sec) -0.52990 0.78258	-0.73854 0.73225	- () - (1) - (6) 10 () () - (6) 10 () (- 2) 3 () ()
		Earth Dep I	Helio Arr	Mars Dep Heli	Earth io Arr	77 78 5 - 2	¥802.33 €	- <u>-</u>
limes (da) Depart// Flight/:	Arrive	0.30		710.25 28.35 190.0	900.25		.U.F.O	
Apcapse	roits radii) Distance e Distance	12.09	0.00	10.95 1.07	0.00 0.00	₹in = 16		
Minimum	t Distances (A Heliocentric Heliocentric ric	0	.9841 .4996 1.1286	1.016 1.655		1.	33 56	<del></del>
Vinf (km Eff Del' Vel Loss Propelli Burn tim Thrust Spec Imp Liss Chan- Cry Star	ion Type m/sec) ta-V (km/sec) ses (m/sec) ant (kg or t) me (hr: (lbs or klbs) p (sec. ges (kg or t) ge Jettisoned	Vloss 3.93 1.20 31.79 24.86 0.29 24.75 463.4	None 5.45 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	Vloss 2.80 0.98 0.0 2.97 9.25 0.10 24.75 442.1	0.00	$AV_{21} - AV_{25} = WEDGEL = 225$ $AV = 125$	2.520	7
AeroBra Orop Ma	Separated Re Separated ss Left Mass Added			13.10 0.00 0.00	0.00 0.00 0.00			

o l lunverged,

	tay Time	Separ	:						Ar	rive	•					F	light Time (days)
	(days)	Earth		JAN 22, J		Date :	56680.	.0000	Ма	rs		JUL :		014, 12.0 lian Date			181.3000
õ	328.2510	Mars		JAN 1,			hours		Ea	rth		JUL	9, 2	016, 19.0 lian Date	967 hour 57579	s GMT 0.2540	190.0000
														T	otal Dur	ation	999.2540
						SPACEC	RAFT N	MASS SU	MMARY	(kg	or t)						
Leg	Initial	Engine	- Depart			Engine					Inert	Pro	obes	AeroBrk	Drops	: Sample	s NetMass
:	107.829 45.905	6.000 6.300	25.5 9.2		000 000	0.000		.000 .000	0.000		0.600 0.600			13.100			0 45.305 0 5.200
						DEPA	RTURE	/ARRIVA	L COND	ITIC	ons						
Leg 1 2	V {k 4.0	Inf [m/s) (c 0097 (c 9974 22	ecl Ri leg) 1.08 1	Asc (deg) 61.95	Brn Tm (min) 17.551	De	1 V /s) 685	VLoss (m/s)		) - <u>5</u> . 6.	V Inf (km/s) 44266	De (de -9 15	ecl eg) .45	Rt Asc (deg)	Brn Tm (min) 0.000	Del (km/s 0.0000	) (m/s) 0 0.000
					H	ELIOCEN	TRIC :	TRANSFE	R ORBI								
1	Semi-Axis (AU) 1.2447796 1.3029500	0.2293	52802	Inclinat (deg) 0.849 1.651	24 3	Asc Nod (deg) 02.0931 07.7794	8 1	Arg Per (deg) 49.9033 32.3997	Tr 6 3	ue A (deg 0.19	Anom 3) 9507	Arr: True (de 158.5	Anor eg) 58491	(AU 0.9592	7) 1851 1.	Aphelion (AU) 5302720 6780317	
					LAUN	CH DELT	A V 01	RIENTAT	'ION -	PLAN	VETOCE!	NTRIC					
		Altitude (km) 800.0000 800.0000	00 5:	lination (deg) 1.60000 1.60000	(km/ 1.2 1.2	sec) 2685	Declii (de -37.4 37.5	40238	1,24	deg)	) )70 -		ec) 315	Y Dot (km/sec) 0.80241 0.80174	(km/s -0.74	sec) 1520	- , 4, • , 45 - • 60 1
			Earth		·	Mars	MIS	SION OF	ERATIO Eart			A		×		sc	
	rt/Arrive			Helio	181.00				899.2			A)	22	4 V =	, 1 5 7 1,5	2 2 1 <sup>2</sup>	
Tsp/Cap Apoap	ht/Stay p Orbits ( pse Distan apse Dista	ce	12.09		0.00 0.00		10.95		0.0 0.0				<b>,</b> .	, ,	ç.		
Spaceca Minia Maxia	raft Dista num Helioc num Helioc entric	nces (AU) entric		0.9842 1.4995	1.1292		. 6764	1.0166	5								
Vinf Eff D Vel I Prope Burn Thrus	ers ulsion Typ (km/sec) Delta-V (k Losses (m/ ellant (kg time (hr) st (lbs or Imp (sec)	m/sec) sec) or t) klbs)	Vloss 4.00 1.23 34.35 25.51 0.29 24.75 463.4	0.00	0.00		Vloss 2.80 0.98 2.97 9.25 0.10 24.75 442.1	0.00	0.0	100000000000000000000000000000000000000				/		1 1 <sup>2</sup>	
Ory 3 Probe Aerol Orop	hanges (kg Stage Jett es Separat Brake Sepa Mass Left Le Mass Ad	isoned ed rated	6.00		0.00	17.31 13.10 0.00 0.00	6.30		0.0 23.5 0.0 0.0	6 10 10					1.277 1820 1820	2	
											, <b>^</b> .	: :	<i>:</i>	ئ . ئ ـ :	, <u> </u>		

AV = 1240 TYSEC

1 Cityerged)

; 3.	tay Time (days)	Depart	:				Arri	.7 <del>e</del>				Fl	ight Time (days,	
	,	Earth	JA		12.0000 hour Date   56681		Mars	;	JUL 22, 20 Jul	014, 12.0 lian Date	000 hours 56861.		180.5500	
=	329.2540	Mars	JA	N 1, 2016,	18.0964 hour Date 57389	s GMT	Eart	:h	JUL 9, 2'	016, 13.0 lian Date	964 hours 57579.		190.0000,	
										Ţ	otal Dura	tion	999.2540	
					SPACECRAFT	MASS SU	MMARY ()	(g or t)			•			
Leg	Initial		•	Tankage	Engine Pro			Inert	Probes	AeroBrk	Drops	Samples	NetMass	
:	108.520 45.905	6.000 6.300	26.203 9.245			0.000	0.000	0.600 0.600		13.100	0.000	0.000	45.305 6.200	
					DEPARTURE	E/ARRIVA	L CONDII	CIONS						
Leg : 2	(k: 4.0	Inf De m/s) (de 7408 0	ecl Rt eg) (d	Asc Brn Tr eg) (min .78 18.02	(km/s) 7 1.25588	VLoss (m/s) 37.229 2.970		V Inf (km/s) 5.44450	Decl (deg) -9.57	Arri Rt Asc (deg) 313.42 84.03	Brn Tm (min) 0.000 0.000	Del V (km/s) 0.00000 0.00000	1m/ <b>s</b> l 3.983	
				I	HELIOCENTRIC	TRANSFE	R ORBIT	ELEMENT	s					
leg	Semi-Axis (AU) 1.2437000 1.3029500	0.23020	06342	0.83755	(deg) 303.11043 1	Arg Per (deg) 148.7410 232.3997	True (c 8 31.	arture 2 Anom deg) .35737 .26414	Arrival True Anom (deg) 158.73004 307.54157	(AU 0.9573	i) 1924 1.5	helion (AU) 300077 780317	Period days; 506.6078 543.2378	22
		•••	T1:		NCH DELTA V				NTRIC X Dot	Y Dot	Z Do			
		Altitude (km) 800.00000	(d 0 51.	eg) (km. 60000 1.3	/sec) (d 25588 -36.	lnation deg) .78965 .42859		eg) 11103	(km/sec)	(km/sec) 0.82275 0.81945	(km/se -0.752	c) -	1245	
				!,	21865 MIS	1/5 - 5 C			_	٨		٠.	1545	`? ~ (
			Earth Dep	Helio Arr	Mars Dep	Helio	Earth Arr		NZ 2	= دَيْلا	. 499	93 1 1 	•	
	(days) rt/Arrive ht/Stay		0.00	180.00		5 190.00	898.25		WED	15 V	= 1.1	, , , , , , , , , , , , , , , , , , ,	, 7, 737	er Lajar
Appa	p Orbits ( pse Distan apse Dista	ce	12.09	0.0			0.00		۷ <sup>ک</sup> کا	= 27 = 12	9,26: 36	, , <u>, , , , , , , , , , , , , , , , , </u>	27, 737	1/2
Minir Maxir	raft Dista mum Helioc mum Helioc entric	entric	0	.9843 .4995 1.129		1.0166 1.6574								
Vinf Eff   Vel   Prope Burn Thru	ers ulsion Typ (km/sec) Delta-V (k Losses (m/ ellant (kg time (hr) st (lbs or Imp (sec)	m/sec) sec) or t) klbs;	Vloss 4.07 1.26 37.23 26.20 0.30 24.75 463.4	Non. 5.4 0.00 0.0 0.00 0.0 0.0 0.0 0.0	4 2.86 0 0.98 0 2.9 0 9.29 0 0.10 0 24.79	0.00 7 5 0.00 0	0.00							
Ory Prob Aero Orop	hanges (kg Stage Jett es Separat Brake Sepa Mass Left Le Mass Ad	isoned ed rated	6.00	0.0	0 6.30 17.31 13.10 0.00 0.00	0	0.00 23.56 0.00 0.00							

AeroBrake Separated

Prop Mass Left Sample Mass Added PERFORMANCE SUMMARY

Turverged: Flight Time - 4 Stay Time Arrive Depart (days) days. JAN 24, 2014, 12.0000 hours GMT \_\_\_ Mars \_\_\_ JUL 23, 2014, 12.0000 hours GMT Earth Julian Date \56682.0000 Julian Date 56862.0000 JUL 9, 2016, 18.0962 hours GMT Julian Date 57579.2540 JAN 1, 2016, 18.0962 hours GMT Earth 190.0000 527.2540 Mars Julian Date 57389.2540 Total Duration 897,2540 SPACECRAFT MASS SUMMARY (kg or t) Leg 6.000 26.913 0.000 0.000 0.000 0.000 17.312 13.100 0.000 0.000 45.305 6.300 9.245 0.000 0.000 0.000 0.000 0.000 23.560 0.000 0.000 0.000 6.200 109.230 45.905 DEPARTURE/ARRIVAL CONDITIONS ----- Depart ---------- Arrive -----V Inf Decl Rt Asc Brn Tm Del V VLoss Leg (deg) (min) (km/s) (m/s) 18.515 1.28550 40.342 6.068 0.97502 2.970 (min) (km/s) (m/s) (dea) (km/s) 4.14704 0.61 161.29 2.79974 22.30 160.17 HELIOCENTRIC TRANSFER ORBIT ELEMENTS Departure Arrival Period Semi-Axis Eccentricity Inclination Asc Node Arg Per True Anom True Anom Perihelion Aphelion Leg 
 (AU)
 (deg)
 (deg)
 (deg)
 (deg)
 (deg)
 (deg)
 (deg)
 (AU)
 (AU)

 1.2405997
 0.230126899
 0.85250
 304.13058
 147.33440
 32.76097
 159.65548
 0.9551043
 1.5260951

 1.3029500
 0.287871111
 1.65105
 107.77947
 232.39973
 194.26414
 307.54157
 0.9278684
 1.6780317
 .days: 504.71468 543.23791 LAUNCH DELTA V ORIENTATION - PLANETOCENTRIC Y Dot Inclination Delta V Declination Rt Ascension X Dot Z Dot Altitude 
 Letta v
 Jeetination
 Rt. Ascension
 X Doc.
 1 Doc.
 2 Doc.

 (km/sec)
 (deg)
 (deg)
 (km/sec)
 (km/sec)
 (km/sec)

 1.28550
 -36.25913
 125.25832
 -0.59837
 0.84642
 -0.76030

 1.28550
 37.24309
 124.71857
 -0.58285
 0.84116
 0.77798
 (km) (deg) 800.00000 51.60000 (km/sec) 165436 0.77798 1.28550 800.00000 51.60000 . 50 . . . . 1245 NO 5-LOSSES AV2, 0 1 V25 = . 999955 MISSION OPERATIONS Earth Earth Mars Dep Helio Arr Dep Helio Arr 415 063 AMES = 5.54 -0 Times (days) 0.00 180.00 707.25 190.00 897.25 Depart/Arrive AV2 = 224,862 - 225,30 (2) Flight/Stay Esc/Cap Orbits (radii) 10.95 0.00 12.09 0.00 Apoapse Distance 0.00 0.00 1.07 Periapse Distance 1.13 AV = 1249 pacecraft Distances (AU) Minimum Heliocentric 0.9844 1.0166 1.4982 1.6574 0.0000 1.1356 1.6764 Maximum Heliocentric 0.0000 Geocentric Maneuvers Propulsion Type Vloss None Vloss None 4.15 Vinf (km/sec) 5.38 2.80 6.81 0.98 0.00 Eff Delta-V (km/sec) 0.00 0.00 0.00 2.97 0.00 Vel Losses (m/sec) 40.34 0.00 9.25 0.00 0.00 Propellant (kg or t) 26.91 0.10 0.00 0.00 0.31 Burn time (hr) Thrust (lbs or klbs) 24.75 0.00 0.00 463.4 0.0 442.1 0.0 Spec Imp (sec) Mass Changes (kg or t) Dry Stage Jettisoned 0.00 6.00 0.00 6.30 17.31 Probes Separated 23.56

0.00

0.00

0.00

13.10

0.00

· · · · · · · · · · · · · · · · · · ·	PERFORMANCE SUMMARY	
: Stay Time Dep days:	rt 5 Arrive	Flight Time (daya)
Ear	h JAN 25, 2014, 12.0000 hou <u>rs GMT</u> Mars JUL 24, Julian Date   56683.0000 t	2014, 12.0000 hours GMT 186.0000 Julian Date 56863.0000
506.2540 Mar	JAN 1, 2016, 18.0960 hours GMT Earth JUL 9, Julian Date 57389.2540	2016, 18.0960 hours GMT 190.7000 Julian Date 57579.2540
		Total Duration 496.2543
	SPACECRAFT MASS SUMMARY (kg or t)	
Leg Initial Engi	Depart e Propell Tankage Engine Propell Tankage Inert Probe	s AeroBrk Drops Samples NetMass
1 109.984 6.0 2 45.905 6.3	· · · · · · · · · · · · · · · · · · ·	
	DEPARTURE/ARRIVAL CONDITIONS	
Leg V Inf	Decl Rt Asc Brn Tm Del V VLoss V Inf Decl	Rt Asc Brn Tm Del V VLoss
	deg)     (deg)     (min)     (km/s)     (m/s)     (km/s)     (deg)       0.81     160.85     19.034     1.31677     43.831     5.31761     -9.57       2.30     160.17     6.068     0.97502     2.970     6.81300     15.54	
	HELIOCENTRIC TRANSFER ORBIT ELEMENTS	
eg Semi-Axis Eccen (AU) 1 1.2375134 0.23 1 1.3029501 0.28		om Perihelion Aphelion Period (AU) (AU) (days) 44 0.9527183 1.5223084 502.93242
	LAUNCH DELTA V ORIENTATION - PLANETOCENTRIC	
Altitu (km) 800.00 800.00	(deg) (km/sec) (deg) (deg) (km/sec) 00 51.60000 1.31677 -35.72819 125.44790 -0.61995	
	Earth Mars Earth Dep Helio Arr Dep Helio Arr	
Times (days) Depart/Arrive Flight/Stay	0.00 180.00 706.25 896.25 180.00 526.25 190.00	
Est/Cap Orbits (radii) Apoapse Distance Periapse Distance	12.09 0.00 10.95 0.00 1.13 0.00 1.07 0.00	
Spacecraft Distances (A Minimum Heliocentric Maximum Heliocentric Geocentric	0.9845 1.0166 1.4969 1.6574 0.0000 1.1420 1.6764 0.0000	
Maneuvers Propulsion Type Vinf (km/sec) Eff Delta-V (km/sec) Vel Losses (m/sec) Propellant (kg or t) Burn time (hr) Thrust (lbs or klbs) Spec Imp (sec)	Vloss         None         Vloss         None           4.22         5.32         2.80         6.81           1.32         0.00         0.98         0.00         0.00           43.83         0.00         2.97         0.00         0.00           27.67         0.00         0.00         9.25         0.00         0.00           0.32         0.00         0.10         0.00         0.00           24.75         0.00         24.75         0.00         0.00           463.4         0.0         442.1         0.0	• 66/37
Mass Changes (kg or t) Dry Stage Jettisoned Probes Separated AeroBrake Separated Drop Mass Left Sample Mass Added	6.00 0.00 6.30 0.00 17.31 23.56 13.10 0.00 0.00 0.00 0.00 0.00	- • ₹ ♥ 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

1.60° - 1.50° - 1.50° 

### PERFORMANCE SUMMARY

	dov	PERFORMANCE SUMMAN	RY
⊹; Stay Time Depa	art	Arı	rive Flight Time
.days≀ . East	th JAN 26, 2014, 12.00	00 hours GMT Mar	
001.1640 <b>Mar</b> :	JAN 1, 2016, 18.09		Julian Date 56868.0000 rth JUL 9, 2016, 18.0957 hours GMT 190.0000
	Julian Date	57389.2540	Julian Date
	SPAC	ECRAFT MASS SUMMARY	(kg or t)
	Depart ne Propell Tankage Engi	Arrive ne Propell Tankage	
	00 28.386 0.000 0.0 00 9.245 0.000 0.0		
	DE	PARTURE/ARRIVAL CONDI	ITIONS
	Depart		Arrive
Leg V Inf	Decl Rt Asc Brn Tm (deg) (deg) (min) ( 0.57 159.31 19.528 1.	Del V VLoss km/s) (m/s) 34636 47.335	V Inf         Decl         Rt Asc         Brn Tm         Del V         Vloss           (km/s)         (deg)         (deg)         (min)         (km/s)         .m/s:           5.01397         -9.05         311.66         0.000         0.0000         0.000           6.81300         15.54         84.03         0.000         0.0000         0.0000
	HELIOC	ENTRIC TRANSFER ORBIT	T ELEMENTS
		Dep	parture Arrival
eg Semi-Axis Eccent (AU) 1 1.2277061 0.220 2 1.3029501 0.281		) (deg) ( 965 143.69927 36	ue Anom (deg)         True Anom (deg)         Perihelion (AU)         Aphelion (AU)         Period (AU)           6.38050         164.49424         0.9491225         1.5062896         436.86683           4.26415         307.54158         0.9278684         1.6780319         543.23794
	LAUNCH DE	LTA V ORIENTATION - F	PLANETOCENTRIC
Altituc (km) 800.000 800.000	(deg) (km/sec) 000 51.60000 1.34636 000 51.60000 1.34636	(deg) (d	cension         X Dot         Y Dot         Z Dot           deg)         (km/sec)         (km/sec)         (km/sec)           .31120         -0.61720         0.90441         -0.78346           .83572         -0.60256         0.89888         0.80103
	Earth Mars		
Cimes (days)	Dep Helio Arr	Dep Helio Arr	
Depart/Arrive Flight/Stay	0.00 184.00 521.2		5
Esc/Cap Orbits (radii) Apoapse Distance Periapse Distance	12.09 0.00 1.13 0.00	10.95 0.00 1.07 0.00	
Spacecraft Distances (AU Minimum Heliocentric Maximum Heliocentric Geocentric	0.9846 1.4904 0.0000 1.1737	1.0166 1.6574 1.6764 0.0000	0
Aneuvers Propulsion Type Vinf (km/sec) Eff Delta-V (km/sec) Vel Losses (m/sec) Propellant (kg or t) Burn time (hr; Thrust (lbs or klbs) Spec Imp (sec)	Vloss None 4.29 5.01 1.35 0.00 0.00 47.33 0.00 28.39 0.00 0.00 0.33 0.00 24.75 0.00 463.4 0.0	Vloss None 2.80 6.81 0.98 0.00 0.00 2.97 0.00 9.25 0.00 0.00 0.10 0.00 24.75 0.00 442.1 0.0	1 0 0 0 0 0 0

6.30

0.00

23.56

0.00

0.00

13.10

0.00

6.00

Mass Changes (kg or t) Dry Stage Jettisoned Probes Separated AeroBrake Separated Drop Mass Left Sample Mass Added

PERFORMANCE SUMMARY

	ិភាព	reged.				PERFORMAN	TE SUMMAR	T					
	ay Time (days)	Depart					Arr	ive				FI	ight Time (days
		Earth	JAN	7 26, 2014, Julian		hours GMT 6684.2000	-	s	AUG 14, 2	2014, 16.8 ulian Date	1000 hours 56884.		200.0000
ŧ	.U0.1540	Mars	/AAL	1, 2016, Julian		hours GMT 7389.2540		th	JUL 9, 2	2016, 19.0 ilian Date			190.0000
										T	otal Dura	ition	895.0540
					SPACECR	AFT MASS :	SUMMARY (	kg or t)					
Leg	Initial			Tankage		Arrive Propell	Tankage	Inert	Probes	AeroBrk	Drops	Samples	NetMass
1 2	110.681 45.905	6.000 6.300		0.000	0.000	0.000	0.000 0.000		17.312 23.560				43.305 6.200
					DEPAR	TURE/ARRI	VAL CONDI	TIONS					
				Depart									
Leg 1 2	V (kr 4.28	Inf De- n/s) (de- 3990 -2.	cl Rt A g) (de 18 155.	sc Brn 1	m Del ) (km/ 3 1.345	V VLos s) (m/s 48 47.23	55 5) 27	(km/s)	Decl (deg) -6.53 15.54	(deg) 306.78	(min) 0.000	(km/s) 0.00000	(m/s) 0.000
2	4.	,,,,	30 100.										
					HELIOCENT	RIC TRANS							
,	(AU)	0 21726	0067	lination (deg) 1.50657 1.65105	(deg) 306.41051	(deg) 141,238	er Tru ) ( 363 38	e Anom deg) .81359	Arrival True Anom (deg) 175.67506 307.54158	n Perihe (AU 5 0.9458	I) 8322 - 1.4	(AU) 708893	Period (days) 485.16932 543.23794
				LAU	NCH DELTA	. V ORIENTA	ATION - P	LANETOCE	NTRIC				
		Altitude	Inclin	ation De	lta V D	eclination	n Rt Asc	ension	X Dot	Y Dot	Z Do	t	
		(km) 800.00000 800.00000	(de 51.6	g) (km 00000 1.	/sec) 34548	-37.81213	119.	38488	(km/sec) -0.52157 -0.57650	0.92621	0.824	88	
						MISSION (	PERATION	S					
			Earth Dep H	elio Arr	Mars	Dep Heli	Earth lo Arr						
	(days) t/Arrive nt/Stay		0.00		0 . 70	5.05	895.05						
Esc/Cap Apoap	o Orbits () ose Distand opse Distan	radii) ce	12.09	0.0		0.95 1.07	0.00						
Minim Maxim	raft Distar num Helioce num Helioce ntric	entric entric	0.	9846 4697 1.273	3 1.	. 1.010 1.657	56,						
Vinf Eff D Vel I Prope Burn Thrus	ers elsion Type (km/sec) Delta-V (kr cosses (m/s ellant (kg time (hr) tt (lbs or Imp (sec)	n/sec) sec) or t)	47.23	Non 4.2 0.00 0.0 0.00 0.00 0.00 0.0	4 0 0 0 0 0 0 0	0.10 4.75	0.00 0.00 0.00			2:			

0.00 23.56 0.00 0.00 0.00

6.00 0.00 17.31 13.10 0.00 0.00

6.30

Mass Changes (kg or t)
Dry Stage Jettisoned
Probes Separated
AeroBrake Separated
Drop Mass Left
Sample Mass Added

, and the second	10/11	51112 LV 35 3 X 11 0 11 11	
r Stay Time - Separt days		Arrive	Flight Time (days)
Easts	ელგ 8, 2022, 11.0204 hour Julian Date 59830		R 27, 2023, 11.0204 hours GMT 200.0000 Julian Date 60030.9592
519.32 <b>67 Mas</b> s	AUG 23, 2024, 11.9006 hour Julian Date 60545		R 11, 2025, 11.9006 hours GMT (205.000) Julian Date 60745.9959
	00112		Total Duration 915.0367
	SPACECRAFT	MASS SUMMARY (kg or t)	
	Depart Arr	ive	Probes AeroBrk Drops Samples NetMass
	Propell Tankage Engine Pro 63.989 0.000 10.119 14		Probes         AeroBrk         Drops         Samples         NetMass           0.000         0.000         0.000         69.503
1 171.006 12.500 63.503 0.000			52.583 0.000 0.000 0.000 5.805
	DEPARTURE	/ARRIVAL CONDITIONS	
Leg V Inf De (km/s) (de 1 4.29600 44.	(deg) (min) (km/s) 30 59.80 23.764 1.84618	VLoss V Inf (m/s) (km/s) 68.212 3.78554 -	Decl Rt Asc Brn Tm Del V VLoss (deg) (deg) (min) (km/s) (m/s) 19.36 186.20 11.153 1.54222 17.509 -8.06 336.53 0.000 0.00000 0.000
3.33.74			
.AU; 1 1.3873974 0.27385	city Inclination Asc Node (deg) (deg) 7472 2.95727 345.46737 3	(deg) (deg) 58.76193 1.24739 143	ue Anom Perihelion Aphelion Period
	PLANETOCENTRIC	CAPTURE ORBIT ELEMENTS	
traditt	(deg) (deg)	(dea) (dea)	rg Per2 Periapse Apoapse Period (deg) (radii) (radii) (hours) 0.18555 1.0735943 10.9478952 24.60638
	LAUNCH DELTA V O	RIENTATION - PLANETOCENTR	ıc
Altitude (km, 400.00000	(deg) (km/sec) (d	eg) (deg) (km 19508 0.95873 3.	(Dot Y Dot Z Dot (/sec) (km/sec) (km/sec) 74847 0.06273 1.92632 (S S 4 3 . (149 . 45 ) (
	MIS	SION OPERATIONS	73.73.76.14 7 - 43.76
	Earth Mars Dep Helio Arr Dep	Earth Helio Arr	
Times (days)   Depart/Arrive   Flight/Stay	0.00 200.00 715.04 200.00 515.04	915.04	
den Tap Orbits (radi: Aprapse Distance Periapse Distance	1.06 10.95 10.95 1.06 1.07 1.07	0.00	
	1.0075 1.6456 3.0000 1.4093 1.4798	0.9935 1.4573 0.0000	
Munwivers  Propulsion Type Vinf (km/sec) Eff Deita-V (km/sec) Vv1 Losses (m/sec) Propellant (kg or t) Burn time (hr) Thrist (ibs or klbs) Sper Imp (sec)	Vloss         Vloss         Vloss           4.30         3.79         3.84           4.21         0.00         1.54         1.57           218.62         17.51         9.95         63.99         0.00         14.90         11.11           0.80         0.19         0.14         45.00         45.00         45.00           917.0         917.0         917.0         917.0	None 6.26 0.00 0.00 0.00 0.00 0.00 0.00 0.00	
Tiss Thanges .kg or to Dry Stage Jettisoned Pribes Separated Aerodrake Separated Tip Mass Left Imple Mass Added	12.50 10.12 0.00 0.00 0.00 0.00 0.00	0.00 52.58 0.00 0.00	

[ PERFORMANCE SUMMARY

eri Stay da	T.50	le:	aft							Arr	ive					gnt Time (days)
		8.43	th.	38			12.000 Date			Mar	s	MAR 28, 2	2023, 12.0 ilian Date			100.3000
; °.	• (5) •	Mas	: 3	AU			11.900 Date			Ear	th	MAR 11, 2	025, 11.9 11ian Date			100.9000
													Т	otal Dura	ition 3	113.9959
											kg or t)					
Day In	.:t.31	Engi	.ne Pr	part opell	Tani	kage	Engin	e Pro	rive opell T	ankage		Probes			Samples	
: 17 2 6	0.609 9.503	12.5	600 6 000 1	3.840 1.115	0	.000	0.00	9 14	1.647	0.000		0.000 52.583			0.000	
									E/ARRIVA							
Qe ş		Inf	Decl	Rt	Asc	Brn Tr	n D	el V	VLoss (m/s)		V Inf	Decl (deg) -19.22	Rt Asc	Brn Tm	Del V	VLoss
1 83			. 16	O bro		24 AQ	191	6867	149 716			-8.06				
						I	HELIOCE	NTRIC	TRANSFE	R ORBIT	ELEMENT	S				
	.AU.	2 22	nenace.	2	(deg)	) 526 :	(deg) 146-479	na s	(deg) 357 7174	Tru ( 9 2	e Anom deg) .29092	144.00226	n Perihe (AU 5 1.0070	604 1.7	645014	Period (days) 595.85459 469.10712
						P!	LANETOC	ENTRIC	CAPTUR	E ORBIT	ELEMENT	S				
	2 ** * *				(dea)	1	(dea)		(dea)	(	dea)	Arg Per2 (deg) 150.23883	(radi	i) (r	oapse adii) 478952	Period (hours) 24.60638
						LAUI	NCH DEL	TA V C	ORIENTAT	ION - P	LANETOCE	NTRIC				
		Altitu (km) 400.00		(d	eg)	n Dei (km) 4.1	(sec)	( c	deg)	(d	eg)	X Dot (km/sec) 3.75674	(km/sec)	(km/se	c)	
								MIS	SSION OP	ERATION	s					
				rth ep	Helic	Arr	Mars	Dep	Helio	Earth Arr						
Times :day Depart/A Flight/S	s. rrive tay		0	.00 2	00.00	200.00	514.00	714.00	200.00	914.00						
Bac/Cap Ori Apoapse ( Pertupse	bits (r Distand Distan	adii) e ce	1	.06		10.95	5	10.95	5	0.00						
Space traft Min.mum ( Maximum ) Se. sentr	Distan Helioce Helioce ic	ces (A ntric ntric	.U1 0.0	1 000	.0072 .6463	1.4190	3	1.4798	0.9935 1.4573	0.0000						
Maneuvers Propulsin Vinc :km Eff Delt Vel Loss Propella Burn tim Corust ( Spec Imp	on Type /sec) a=V (km es (m/s nt (kg e (hr) lbs or .sec)	ysec) ec' or t) klbs)	V1 4 4 217 63 0 45	0ss .30 .21 .63 .84 .90 .00	0.00	Vloss 3.75 1.52 16.61 14.65 0.18 45.00	5 5 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	Vloss 3.84 1.57 9.95 11.11 0.14 45.00 917.0	0.00	None 6.26 0.00 0.00 0.00 0.00						
Mass Chang Cry Stag Grubes S Aet Brak G Mas Unite M	e Jetti eparate e Separ s Left	soned d ated	12	.50		10.13	0.00			0.00 52.58 0.00 0.00						

PERFORMANCE SUMMARY

	ray Cimer Nay Di	Depart							Arr	ive					ght Time (days)
		Earth	:			12.0000 h Date 59			Mars	5	MAR 29, 20 Ju.	023, 12.0 lian Date	000 hour 60033	s GMT 2	00.000
	12. 653	Mars	1			11.9004 h Date 60			Eart	th	MAR 11, 20 Ju.	025, 11.9 Lian Date	004 hour 60745	s GMT 2	00.0000
												Ţ	otal Dur	ation 9	12.9953
						SPACECRA				kg or t)					
Do g	Initial	Engine	Depar Prope	ll Tank	age	Engine	Arrive - Propell	Ta	nkage	Inert	Probes	AeroBrk	Drops	Samples	NetMass
	170.266 69.503	12.500	63.7		000 000	10.119	14.412		0.000	0.000 0.000	0.000 52.583	0.000		0.000	
						DEPART	URE/ARRI	VAL							
Leg :		1/s) (de	ecl Ri	Asc (deg)	Brn Tm (min) 23.670	Del (km/s 1.8470	V VLC ) (m/ 0 67.7	oss (s) 742		V Inf	Decl	Rt Asc	Brn Tm	Del V (km/s) 1.49606	VLoss
-		Cast = 5794 0.	4.61 h:	rs 29.07	8.322	1.5670	6 9.9	952		6.26432	-8.06	336.53	0.000	0.00000	0.000
					Н	ELIOCENTR	ic trans	SFER	ORBIT	ELEMENT	s				
Dep	(AU)			(deg)	17 7	(deg)	(dec	3) 1265	True	e Anom deg)	Arrival True Anom (deg) 144.49113 302.24575	1 0066	3164 1.	Aphelion (AU) 7617676 4573200	Period (days) 594.83008 469.10711
					PL.	ANETOCENT	RIC CAPT	rure	ORBIT	ELEMENT	S				
263	Semi-Axis (radil) 6.0107448	Eccentri 0.82138	.city .	Inclinat (deg) 37.000	ion A 00 2	sc Nodel (deg) 13.76091	Arg E (dec 264.49	Perl 9) 9447	Asc (0 339	Node2 deg) .12667	Arg Per2 (deg) 150.27995	Peria (radi 1.0735	ipse <i>F</i> (i) (	Apoapse (radii) 9478952	Period (hours) 24.60638
					LAUN	CH DELTA	V ORIENT	TATI	ON - P	LANETOCE	NTRIC				
		Altitude (km) 400.00000		lination (deg) 3.86118	(km/		clinatio (deg) 26.74616		(de	eg)	X Dot (km/sec) 3.76522	Y Dot (km/sec) -0.04722	(km/s	sec)	
							MISSION	OPE	RATION:	S					
			Earth Dep	Helio	Arr	Mars D	ep Hel	lio	Earth Arr						
Cimes Cepai Fligh	(days) rt/Arrive nt/Stay		0.00	200.00	200.00	713 513.00	200	.00	913.00						
dso Dap Appap Peris	o Orbits (: pse Distant apse Distar	radii) de noe	1.06		10.95	10	95 07		0.00						
Oplaced: Minis Makis Geom	raft Distar mum Helloce mum Helloce entric	nces (AU) entric entric	0.0000	1.0070	1.4292	1.4	0.99 1.49 798	935 573	0.0000						
Markedye	ers ulsion Typekm_sec  Delta=Vikm Losses (m/s eilant (kgtimekr) st(lbs_or _ Imp(sec)					171	1.84 57 0	.00	None 6.26 0.00 0.00 0.00 0.00 0.00						
Dry Brabe Aerol 105	nanges (kg Stage Jett) es Separate Brake Sepai Mass Left Le Mass Add	isoned ed rated	12.50		10.12	0.00 0.00 0.00 0.00	0.00		0.00 52.58 0.00 0.00 0.00						

### PERFORMANCE SUMMARY

	12.15.78	rigea)					( = 1.1.0		03.22						
	tay Ture days.	Depar'	:						Arri	.ve					ight Time (days)
		Earth	S	EP 11,		12.0000 Date			Mars	5	MAR 30, 2 Ju	023, 12.0 lian Date	000 hour:	s GMT :	200.1000
	-11.7454	Mars	P	.UG 23,		11.9003 Date			Eart	:h	MAR 11, 2	025, 11.9 lian Date	003 hours 60745		200.5000
				0	dilan .	Da Le	00545.	,,,,,				1	Total Dura	ation	911.9958
						SPACEO	RAFT M	ASS SU	MMARY ()	(g or t)					
			- Separt				- Arri	ve				1eroBrk	Drops	Samples	Ne-Mass
Les	Initial 169.959	Engine 12.500			age 000	Engine			o.ooo	Inert 0.000		0.000	0.000	0.000	63.503
3		0.000				0.000		000	0.000	0.000	52.583	0.000	0.000	0.000	5.805
						DEPA	ARTURE/	ARRIVA	L CONDI						
Leg :	V (kd 4.3	m/s) (de 1482 43	ecl Rt eg) ! .37 5	: Asc (deg) 66.63	Brn Tm (min) 23.643 24.020	De (km 1.84 2.37	el V n/s) 1835 7173 1	(m/s) 67.676		V Inf (km/s) 3.67749	Decl (deg) -18.93	Rt Asc (deg) 186.54	Brn Tm (min) 10.617	Del V	VLoss (m/s) 15.014
					н	ELIOCEN	NTRIC T	'RANSFE	R ORBIT	ELEMENT	'S				
193 1	Semi-Axis (AU) 1.3425683 1.1915417	0.2722	95783	(nclinat (deg) 2.868 0.322	ion .	Asc Noc (deg) 48.4245	de A	rg Per	Department (1	arture e Anom	Arrival True Anom (deg) 144.98922	1.006		7590358	Period (days) 593.78375 469.10711
					PL	ANETOCE				ELEMENT					
led:	Semi-Axis .:33311. 6.0107446			Inclinat (deg) 37.000		(deq)		Arg Per (deg) 55.0798	(-	Node2 deg) .46967	Arg Per2 (deg) 150.31042	(rad	11) (	radii	Period (hours) 24.60638
					LAUN	CH DELT	TA V OF	RIENTAT	'ION - P	LANETOCE	ENTRIC				
		Altitude (km) 400.0000		lination (deg) 3.37384		sec)	(de		Rt Asc (d 358.		X Dot (km/sec) 3.77438	Y Dot (km/sec -0.0968	) (km/s	ec)	
							MISS	SION OF	PERATION	s					
			Earth Dep	Helio		Mars	Dep	Helic	Earth Arr						
Depa	days: art/Arrive gnt/Stay		0.00	200.00	200.00		712.00	200.00	912.00						
Apple	ap Orbits ( ipse Distan Lapse Dista	ce	1.06		10.95		10.95		0.00 0.00						
Mini Maxi	oraft Dista imum Helioc imum Helioc centric	entric entric		1.0067 1.6475				0.9935							
Eff Vel Prop Surr Thri	Vers  Culsion Typ  (km/sec)  Culsia-V (k  Losses (k  peliant (kg  culsiant (kg  culsia	m/sec) sec) ( or t) ( klbs)	Vloss 4.31 4.22 216.83 63.66 0.79 45.00 917.0	0.00	15.01	3333	Vloss 3.84 1.57 9.95 11.11 0.14 45.00 917.0	0.00	0.00	i 					
Dry Fina Aei Top	Changes (kg Stage Jett Des Separat DEsake Sepa p Mass Left ply Mass Ad	isoned ed irated :	12.50		10.12	0.00 0.00 0.00 0.00			0.00 52.58 0.00 0.00	3 ) )					

1.0053 1.7022 0.0000 2.5432

Vloss None 3.71 3.07 1.11 0.00 0.00 16.60 0.00 18.28 0.00 0.00

0.00 0.00 0.0

0.00 0.00

9.80 0.00 0.00

1.11 16.60 18.28 0.22 24.00

461.4

4.40

Spacecraft Distances (AU) Minimum Heliocentric Maximum Heliocentric

Jeocentric Maneuvers

Propulsion Type

rispulsion Type
Winf (km/sec)
Eff Delta-V (km/sec)
Wel Losses (m/sec)
Propellant (kg or t)
Burn time (hr)
Thrust (lbs or klbs)
Gpe: Imp (sec)

Mass Inanges (kg or t) Ir, Itage Jettisoned Proces Separated

AeroBrake Separated Trop Mass Left Sample Mass Added

DEBEODMANCE CUMMARY

i i linverged;		PERFORMANCE SUMMA	RY		
-a Stay Time Separt (days)		Ar			ignt Time (days)
] Earth	SEP 14, 2022, 16.21 Julian Date	76 hours GMT Ma 59837.1757	oct 2, 2023, Julian	16.4408 hours GMT n Date 60220.1854	383.0096
				Total Duration	383.0096
	SPAC	ECRAFT MASS SUMMARY	(kg or t)		
Lws Initial Engine	Depart Frankara Frank	Arrive	Inert Probes Ae	coBrk Drops Samples	NetMass
	18.278 0.000 0.0				
	DE	PARTURE/ARRIVAL COND	TIONS		
				- Arrive	
	cl Rt Asc Brn Tm g) (deg) (min) ( 73 82.13 12.912 1.	Dal V VI dee	V Inf Decl Rt	Asc Brn Tm Del V	VLoss
	HELIOC	ENTRIC TRANSFER ORBI	ELEMENTS		
( A!!)	city Inclination Asc N (deg) (deg 4533 0.83739 171.53	ode Arg Per Tr	(deg) (deg)	Perihelion Aphelion (AU) (AU) 0053295 1.7022441	Period (days) 575.33903
	LAUNCH DE	LTA V ORIENTATION -	PLANETOCENTRIC		
Altitude .km. 800.00000 800.00000	Inclination Delta V (deg) (km/sec) 28.50000 1.11035 28.50000	Declination Rt Ass (deg) (deg) -8.76212 34 28.47797 25	tension X Dot (km/sec) (km/sec) (km/sec) (km/sec) (km/sec) (km/sec) 0.90552 0.81885 0.87857 0	7 Dot 2 Dot 1/sec) (km/sec) 61993 -0.16914 42507 0.52944	
		MISSION OPERATION	IS		
	Earth Mars				
	Dep Helio Arr				
.ines days) Depart/Arrive Flight/Stay	0.00 383.01 383.01				
	12.09 0.00 1.13 0.00				

for rire name: o		•			PERFORMA	NCE SUMMA	RY					
leg Stay Time	Depart					Ar	rive				F1:	.pht Time (days)
(days) :	Earth	SEP	2, 2022,	12.0000 Date 5			rs	MAR 21, 2	023, 12.0 lian Date	000 hours		100.2000
520.9959	Mars	AUG :	23, 2024,	11.9013	hours GM	·/ IT Ea	rth	MAR 11, 2		013 hours	s GMT	:50.5000
			Julian	Date 6	0343.993	, 9		3.		otal Dura		·20 . 998 4
SPACECRAFT MASS SUMMARY (kg or t)												
Leg Initial		Depart Propell				. Tankage		t Probes	AeroBrk	Drops	Samples	NetMass
1 119.573 2 51.823		31.338 15.765		0.000 0.000	0.000				13.100		0.000 0.000	81.923 6.280
DEPARTURE/ARRIVAL CONDITIONS												
Leg V	Inf Dec (/s) (dec 193 47.0	66.1	c Brn Tr ) (min)	n Del (km/ 3 1.381	V VI s) (m 14 59.	oss (/s) 355	V In: (km/s 3.9993)		Rt Asc (deg) 185.10	Brn Tm (min) 0.000	Del V (km/s) 0.00000	VLoss 'm/s' 0.000 0.000
			I	HELIOCENT	RIC TRAN	ISFER ORBI	T ELEMEN	rs				
	0.277675 0.233405	) 5579 3	deg) .15084 :	Asc Node (deg) 339.68569 170.85059	(de 4.5	Per Tr	ue Anom (deg) 5.48651	Arrival True Anom (deg) 140.84297 302.24569	(AU 1.0082		(AU) 7835119	Period (days) 602.39528 469.10717
			LAU			TATION -						
	Altitude (km) 800.00000 800.00000			/sec) 38114		7 21	deq)	X Dot (km/sec) 1.23730 0.98685	0.47902	(km/se	ec) 188	
					MISSION	OPERATIO	NS					
		Earth Dep He	lio Arr	Mars	Dep He	Eart elio Arr						
Times (days) Depart/Arrive Flight/Stay		0.00 200		72 521.00		921.0 ).00	0					
Esc/Cap Orbits (r Apoapse Distanc Periapse Distan	е	12.09	0.00		0.95 1.07	0.0						
Spacecraft Distan Minimum Helioce Maximum Helioce Geocentric	ntric ntric	1.0 1.6		7 1.		9935 1573 0.000	0					
Maneuvers Propulsion Type Vinf (km/sec) Eff Delta-V (km Vel Losses (m/s Propellant (kg Burn time (hr) Thrust (lbs or Spec Imp (sec)	/sec) ec) or t)	59.36	None 4.06 .00 0.06 0.06 0.06 0.06 0.06	0 0 1 0 1 0 1 0 2	5.41	Non 6.2 0.00 0.0 0.00 0.0 0.00 0.0	6 0 0 0 0 0					

6.00

Mass Changes (kg or t) Dry Stage Jettisoned

Probes Separated AeroBrake Separated Drop Mass Left Sample Mass Added 0.00 17.31 13.10 0.00

0.00

6.30

0.00 23.56 0.00

and (Converged) PERFORMANCE SUMMARY

PERFORMANCE SUMMARY												
লব Stay Time Depart (days)	:	Arrive	Elight Time (days)									
Earth	SEP 4, 2022, 12.0000 Julian Date 5	hours GMT Mars	MAR 23, 2023, 12.0000 hours GMT									
. 518.9959 Mars	AUG 23, 2024, 11.9010 Julian Date 6		MAR 11, 2025, 11.9010 hours GMT 2003.0001 Julian Date 60045.9959									
			Total Duration 318.9969									
SPACECRAFT MASS SUMMARY (kg or t)												
	- Depart	- Arrive Propell Tankage Inert	r Probes AeroBrk Orops Samples NetMass									
1 119 199 6.000	30.964 0.000 0.000	0.000 0.000 0.000	0 17.312 13.100 0.000 0.000 51.323									
2 51.823 6.300	15.765 0.000 0.000	0.000 0.000 0.000	0 23.558 0.000 0.000 0.000 6.200									
DEPARTURE/ARRIVAL CONDITIONS												
Lea Vinf De	Departecl Rt Asc Brn Tm Del eq) (deq) (min) (km/	V Vioss V int	f Decl Rt Asc Brn Tm Del V VLoss ) {deg} (deg) (min) (km/s) m/s									
1 4.32003 46.	eg) (deg) (min) (km/ .38 64.05 21.302 1.366 .42 29.07 10.347 1.572	591 57.261 3.92739	9 -19.82 185.53 0.000 0.00000 0.000 2 -8.06 336.53 0.000 0.00000 0.000									
	HELIOCENT	TRIC TRANSFER ORBIT ELEMENT	TS									
	Table Tablesties Rec Node	Departure • Arg Per True Anom	Arrival True Anom Perihelion Aphelion Period									
(AU) - 1 3931928 0 27629	94349 3.08263 341.62414	(deg) (deg) 1 2.63335 357.37920	(deg) (AU) (AU) (days)									
2 1.1815418 0.23340	0.32231 170.85059											
		A V ORIENTATION - PLANETOCE										
Altitude (km) 800.0000 800.0000	(deg) (km/sec)	Declination Rt Ascension (deg) (deg) 14.79379 19.86671 44.81383 352.26459	(km/sec) (km/sec) (km/sec)									
		MISSION OPERATIONS										
	Earth Mars	Earth										
Times (days)	Dep Helio Arr											
Depart/Arrive Flight/Stay	0.00 200.00 71 200.00 519.00											
Esc/Cap Orbits (radii) Apoapse Distance Periapse Distance	12.09 0.00 1 1.13 0.00	10.95 0.00 1.07 0.00										
Spacecraft Distances (AU) Minimum Heliocentric	1.0083	0.9935										
Maximum Heliocentric Geocentric	0.0000 1.3697 1.	1.4573 .4798 0.0000										
Maneuvers Propulsion Type Vinf (km/sec)	Vloss None V 4.32 3.93	/loss None 3.84 6.26										
Eff Delta-V (km/sec) Vel Losses (m/sec)	1.37 0.00 0.00 57.26 0.00	1.57 0.00 0.00 15.41 0.00										
Propellant (kg or t) Burn time (hr)	0.36 0.00	15.76 0.00 0.00 0.17 0.00 24.75 0.00										
Thrust (lbs or klbs) Spec Imp (sec)		142.1 0.0										
Mass Changes (kg or t) Dry Stage Jettisoned	6.00 0.00	6.30 0.00 23.56										
Probes Separated AeroBrake Separated Drop Mass Left	13.10 0.00	0.00 0.00 0.00										
Sample Mass Added	0.00	0.00										

c

de 1 (Converged) PERFORMANCE SUMMARY															
++4 3	Stay Time (days)	Depart	:						Arr	ive					ignt Time Udays
		Earth				12.0000 Date 5			Mar	s	MAR 25, 2 Ju	023, 12.0 lian Date	000 nours 60029.		230.0000
	516.9959	Mars		AUG 23,	2024, Julian	11.9008 Date 6	hours	GMT 9959	Ear	th	MAR 11, 2	025, 11.9 lian Date	008 hours 60745.	GMT 1 9959	100.9600
												τ	otal Dura	tion :	916.9959
SPACECRAFT MASS SUMMARY (kg or t)															
Leg	Initial	Engine	- Depar Prope	t ll Tan	kage	Engine	Arri Prop	ve bell T	ankage	Inert	Probes	AeroBrk	Orops	Samples	NetMass
: 2		6.000 6.300			.000 .000	0.000 0.000		000 000	0.000		17.312 23.558				51.823 6.200
DEPARTURE/ARRIVAL CONDITIONS															
		Inf De		Depa	rt						Decl				
Leg 1 2	( kn	n/s) (de 0121 45: 3794 0:	ea)	(dea)	(min)	(km/	s)	(m/s)			(deg) -19.60 -8.06		4 7 4	11 ( - 1	( - / - :
						ELIOCENT				ELEMENT	S				
											Arrival				2
Leg	Semi-Axis (AU)			(deg	tion )	Asc Node (deg)	Α.	(deg)			True Anom (deg) 142.59166		)	(AU) 726929	Period (days: 598.79473
1 2	1.3903358			3.01 0.32	232 1	70.85059	5	57.7175	3 173	.15022	302.24572	0.9057	633 1.4		469.10714
					LAUN	ICH DELTA	V OR	IENTAT	ION - P	LANETOCE	NTRIC				
		Altitude		linatio						ension eg)	X Dot (km/sec)	Y Dot			
		(km) 800.00000 800.00000	) 5	(deg) 1.60000 1.60000	1.3	15858	13.3	18983 14365	18.	67918 87332	1.25204	0.42328	0.314	61	
							MISS	ION OP	ERATIONS	S					
			Earth Dep		Arr	Mars	Dep	Helio	Earth Arr						
Depa	(days) irt/Arrive jht/Stay		0.00	200.00	200.00	71 517.00		200.00	917.00						
Apoa	p Orbits (1 pse Distand apse Distan	ce	12.09		0.00		0.95 1.07		0.00						
Mini	raft Distar	entric		1.0080				0.9935							
	mum Helioce entric	entric	0.0000	1.6444	1.3896	1.	4798	1.4573	0.0000						
	ers oulsion Type (km/sec)	2	Vloss 4.30		None 3.86		loss 3.84		None 6.26						
Vel	Delta-V (km Losses (m/s	sec)	1.36 56.06		0.00	) 1	1.57	0.00	0.00						
Burn	ellant (kg time (hr)		30.75		0.00	)	5.76 0.17 4.75	0.00	0.00 0.00 0.00						
	st (lbs or : Imp (sec)	KIDS)	24.75 463.4		0.00		42.1		0.0						
	hanges (kg Stage Jetti		6.00		0.00		6.30		0.00						
Prob Aero Drop	es Separate Brake Separate Mass Left Le Mass Ado	ed cated				17.31 13.10 0.00 0.00			23.56 0.00 0.00 0.00						

-- Converged; PERFORMANCE SUMMARY

330732434			
∴; Stay Time Depar  (days)	t	Arrive	Filight Time dayn.
: Earth	SEP 7, 2022, 12.0000 Julian Date 5		2023, 12.0000 hours GMT
515.9959 Mars	AUG 23, 2024, 11.9007 Julian Date 6		2025, 11.9007 hours GMT
			Total Duration 915.9959
	SPACECR	AFT MASS SUMMARY (kg or t)	
	- Depart Propell Tankage Engine		AeroBrk Drops Samples NetMass
1 118.931 6.000 2 51.823 6.300	30.696 0.000 0.000 15.765 0.000 0.000	0.000 0.000 0.000 17.312 0.000 0.000 0.000 23.558	
	DEPAR	TURE/ARRIVAL CONDITIONS	
Leg V Inf De (km/s) (de 1 4.29688 45 2 3.83794 0	.21 60.82 21.118 1.356	V VLoss V Inf Decl s) (m/s) (km/s) (deg) 68 55.790 3.81981 -19.48	
	HELIOCENT	RIC TRANSFER ORBIT ELEMENTS	
Leg Semi-Axis Eccentr: (AU) 1 1.3888531 0.27440 2 1.1815418 0.23340		(deg) (deg) (deg) 359.71465 0.29549 143.0524	A Perihelion Aphelion Period (AU) (AU) (days) 1.0077400 1.7699662 597.83714
	LAUNCH DELTA	V ORIENTATION - PLANETOCENTRIC	
Altitude (km) 800.0000( 800.00000	(deg) (km/sec) 0 51.60000 1.35668		(km/sec) (km/sec) 0.41156 0.29796
		MISSION OPERATIONS	
	Earth Mars Dep Helio Arr	Earth Dep Helio Arr	
Times (days) Depart/Arrive Flight/Stay	0.00 200.00 71 200.00 516.00		
<pre>isc/Cap Orbits (radii)   Apoapse Distance   Periapse Distance</pre>		0.95 0.00 1.07 0.00	
Spacecraft Distances (AU) Minimum Heliocentric Maximum Heliocentric Geocentric	1.0077 1.6450 0.0000 1.3995 1.	0.9935 1.4573 1798 0.0000	
Vinf (km/sec) Eff Delta-V (km/sec)	4.30     3.82       1.36     0.00     0.00       55.79     0.00     1       30.70     0.00     0.00       0.35     0.00     2       24.75     0.00     2	None 3.84 6.26 1.57 0.00 0.00 5.41 0.00 5.76 0.00 0.00 5.17 0.00 1.75 0.00 1.71 0.00 1.75 0.00	
Mass Changes (kg or t) Dry Stage Jettisoned Probes Separated AeroBrake Separated Drop Mass Left Sample Mass Added	6.00 0.00 17.31 13.10 0.00 0.00	0.00 23.56 0.00 0.00 0.00	

Vinf (km/sec) Eff Delta-V (km/sec) Vel Losses (m/sec) Propellant (kg or t) Burn time (hr) Thrust (lbs or klbs) Spec Imp (sec) Mass Changes (kg or t)

Dry Stage Jettisoned

Probes Separated AeroBrake Separated

Sample Mass Added

Drop Mass Left

(Converged) Elight Time Arrive er Chay Time Depart dayn: (days) Mars MAR 27, 2023, 12.0000 hours GMT SEP 8, 2022, 12.0000 hours GMT Julian Date 59831.0000 Earth Julian Date 60031.0000 200.0000 514.9959 Mars Julian Date 60545.9959 Total Duration 914.9959 SPACECRAFT MASS SUMMARY (kg or t) ------ Depart ------- Arrive ------Leg Initial Engine Propell Tankage Engine Propell Tankage Inert Probes AeroBrk Drops Samples NetMass 118.921 6.000 30.686 0.000 0.000 0.000 0.000 17.312 13.100 0.000 0.000 51.823 51.823 6.300 15.765 0.000 0.000 0.000 0.000 0.000 23.558 0.000 0.000 0.000 6.200 DEPARTURE/ARRIVAL CONDITIONS ----- Arrive ------------ Depart -----V Inf Decl Rt Asc Brn Tm Del V VLoss V Inf Decl Rt Asc Brn Tm Del V VLoss (km/s) (deg) (deg) (min) (km/s) (m/s) (km/s) (deg) (deg) (min) (km/s) (m/s) (m/s) (deg) (deg) (min) (km/s) (m/s) Leg HELIOCENTRIC TRANSFER ORBIT ELEMENTS Departure Arrival Leg Semi-Axis Eccentricity Inclination Asc Node Arg Per True Anom True Anom Perihelion Aphelion Period 
 (AU)
 (deg)
 LAUNCH DELTA V ORIENTATION - PLANETOCENTRIC Altitude Inclination Delta V Declination Rt Ascension X Dot Y Dot 2 Dot (km) (deg) (km/sec) (deg) (deg) (km/sec) (km/sec MISSION OPERATIONS Earth Mars Eart! Dep Helio Arr Dep Helio Arr Earth 915.00 0.00 200.00 715.00 200.00 515.00 Times (days) Depart/Arrive Flight/Stav 10.95 Esc/Cap Orbits (radii) Apoapse Distance 12.09 0.00 0.00 12.09 1.07 0.00 Periapse Distance 0.0000 
 Vloss
 None
 Vloss
 None

 4.30
 3.78
 3.84
 6.26

 1.36
 0.00
 0.00
 1.57
 0.00
 0.00

 55.74
 0.00
 15.41
 0.00
 0.00

 30.69
 0.00
 0.00
 0.17
 0.00
 0.00

 0.35
 0.00
 0.17
 0.00
 0.00
 24.75
 0.00
 0.00
 442.1
 0.0
 Maneuvers Propulsion Type

6.30

17.31

13.10

0.00

0.00

0.00

0.00 0.00

23.56

0.00

0.00

Mass Changes (kg or t) Dry Stage Jettisoned Probes Separated AeroBrake Separated Drop Mass Left Sample Mass Added

6.00

100	Lle Nameri	Doaded Cas	e												
	, Gou∧	ergedi				Ę	PERFOR	MANCE	SUMMAR	Y					
	tay Time (days)	Depart							Arr	ive					ight Time (Zays)
•		Earth	S	EP 9,	2022, 1 ulian D	2.0000 h ate 59	nours 0	GMT 000	Mar	S	MAR 28, 2 Ju	023, 12.0 lian Date	000 hours 60032.	0000	100.0000
	513.9959	Mars	Ą	.UG 23, J	2024, 1 ulian D	1.9005 h ate 60	nours (	GMT 959	Ear	th	MAR 11, 2 Ju	lian Date	. 60:40.	9959	* * * * * * * * * * * * * * * * * * *
												τ	otal Dura	ition	913,4954
						SPACECRA	AFT MAS	SS SUN	MARY (	kg or t)					
Lea	Initial	Fraire	Depart		 age	Engine	Arrive	e	nkage	Inert	Probes	AeroBrk	Drops	Samples	NetMass
1 ?	118.952	6.000 6.300	30.71	7 0.	000						17.312 23.558			0.000	81.823 6.200
									. CONDI						
				- Depar	t		• <b></b> -					Arri	ve		
Leg 1	• •		-1 0-	*	D T-	0-1	11 1	111 000		V Inf (km/s) 3.74844	Decl (deg) -19.22 -8.06	Rt Asc (deg) 186.33	Brn Tm (min) 0.000	Del V (km/s) 0.00000	VLoss (m/s) 0.000 0.000
2	3.8	3794 0.	42 2	9.07	10.347	1.5/23	01 13	5.412		0.20432	-8.00	330.33	0.000	0.00000	0.000
					HE	LIOCENTE	RIC TRA	ANSFER		ELEMENT					
Leg 1 2	(AU) 1 3857809		0302	(deg) 2.926	26 34	(deg) 6.47904	357.	deg) .71749	Tru ( 2	e Anom deg) .29092	Arrival True Anom (deg) 144.00226 302.24574	Perihe (AU 1.0070	604 1.7	645014	Period (days 595.85469 469.10112
					LAUNC	H DELTA	V ORIE	ENTAT I	ION - P	LANETOCE	NTRIC				
		Altitude (km) 800.00000 800.00000	( 51	deg) .60000	Delt. (km/s- 1.35 1.35	ec) 748	(deg)	) 056	(d 17.	eg) 06114	X Dot (km/sec) 1.27263 0.90583	(km/sec) 0.39057	(km/se 0.265	:C) :77	
							MISSI	ON OPE	RATION	s					
7	(4)		Earth Dep	Helio	Arr	Mars (	Dep 1	Helio	Earth Arr						
	rt/Arrive ht/Stay					714 14.00									
Apoa	p Orbits ( pse Distan apse Dista	ce	12.09		0.00		0.95 1.07		0.00						
Mini Maxi	raft Dista mum Helioc mum Helioc entric	entric entric		1.0072	1.4193	1.4		. 9935 . 4573	0.0000						
Vinf Eff : Vel Prope Burn Thru:	ers ulsion Typ (km/sec) Delta-V (k Losses (m/ ellant (kg time (hr) st (lbs or Imp (sec)	m/sec) sec) or t)	Vloss 4.30 1.36 55.90 30.72 0.35 24.75 463.4	0.00	None 3.75 0.00 0.00 0.00 0.00 0.00	15 15 15 0 24	loss 3.84 1.57 5.41 5.76 0.17 1.75	0.00	0.00						

0.00 6.30 17.31 13.10 0.00 0.00

0.00 23.56 0.00 0.00 0.00

- converged; PERFORMANCE SUMMARY

ong Stay Time Depar	···c	Arrive		Pliant Time daya
(days)		hours GMT Mars 59833.0000	MAR 29, 2023, 12.0000 hours Julian Date 60033.	
. 512.9959 Mars		hours GMT Earth 50545.9959	MAR 11, 2025, 11.9004 hours Julian Date 60745.	
			Total Dura	ation 912.9939
		RAFT MASS SUMMARY (kg or t	.1	
	Depart e Propell Tankage Engine	- Arrive Propell Tankage Iner		Samples NetMass
1 119.024 6.000 2 51.823 6.300	30.789 0.000 0.000 15.765 0.000 0.000		00 17.312 13.100 0.000 00 23.558 0.000 0.000	
	DEPAF	RTURE/ARRIVAL CONDITIONS		
Leg V Inf I (km/s) (c 1 4.30496 43		L V VLoss V In (s) (m/s) (km/s) 24 56.299 3.7129		Del V Vloss (km/s) m/s 0.00000 0.000
	HELIOCENT	TRIC TRANSFER ORBIT ELEMEN	ITS	
(AU)	ricity Inclination Asc Node (deg) (deg) 176903 2.89717 347.45155 05482 0.32232 170.85060	(deg) (deg) 5 356.70365 3.30386	True Anom Perihelion Ap (deg) (AU) 144.49113 1.0066164 1.7	helion Period (AU) (days 1617676 594.83008 1573200 469.10711
Altitude (km) 800.0000 800.0000	e Inclination Delta V [	A V ORIENTATION - PLANETOCI Declination Rt Ascension	X Dot Y Dot Z Do	ec) )27
	Earth Mars Dep Helio Arr	Earth Dep Helio Arr		
Times (days) Depart/Arrive Flight/Stay	0.00 200.00 71 200.00 513.00	13.00 913.00 200.00		
Esc/Cap Orbits (radii) Apoapse Distance Periapse Distance	12.09 0.00 1 1.13 0.00	10.95 0.00 1.07 0.00		
Spacecraft Distances (AU) Minimum Heliocentric Maximum Heliocentric Geocentric	1.0070 1.6469	0.9935 1.4573 0.0000		
Maneuvers Propulsion Type Vinf (km/sec) Eff Delta-V (km/sec) Vel Losses (m/sec) Propellant (kg or t) Burn time (hr) Thrust (lbs or klbs) Spec Imp (sec)	4.30     3.71       1.36     0.00     0.00       56.30     0.00     1       30.79     0.00     0.00       0.35     0.00     2       24.75     0.00     2	None 3.84 6.26 1.57 0.00 0.00 5.41 0.00 0.17 0.00 0.17 0.00 4.75 0.00 0.00		
Mass Changes (kg or t) Dry Stage Jettisoned Probes Separated AeroBrake Separated Drop Mass Left Sample Mass Added	6.00 0.00 17.31 13.10 0.00 0.00	6.30 0.00 23.56 0.00 0.00 0.00		

dass Changes (kg or t)
Dry Stage Jettisoned
Probes Separated
AeroBrake Separated
Drop Mass Left
Sample Mass Added

# PERFORMANCE SUMMARY

. : ::::::::::::::::::::::::::::::::::		CBITCOMPACE CONTRACT						
-; Stay Time Dep	part	Arrive		Flight Time days				
Ea	rth SEP 11, 2022, 12.00 Julian Date		MAR 30, 2023, 12.0000 Julian Date	hours GMT 200.0000 60034.0000				
511.9958 Ma	rs AUG 23, 2024, 11.90 Julian Date		MAP 11, 2025, 11.9003 Julian Date	hours SMT   200.0000 60745.9958				
	00110 2023		Tota	1 Duration 911.3358				
	SPAC	ECRAFT MASS SUMMARY (kg or	t)					
Leg Initial Eng.	Depart ine Propell Tankage Engi	Arrive ne Propell Tankage Inc	ert Probes AeroBrk	Drops Samples NetMass				
	000 30.903 0.000 0.0 300 15.765 0.000 0.0			0.000 0.000 51.823 0.000 0.000 6.230				
	DE	PARTURE/ARRIVAL CONDITIONS						
	_		Arrive					
Leg V Inf (km/s) 1 4.31482	(deg) (deg) (min) (	Del V VLoss V I km/s) (m/s) (km/ 36460 56.926 3.677	TRE Decl Rt Asc Br (/s) (deg) (deg) ( /49 -18.93 186.54 0 /32 -8.06 336.53 0	n Tm Del V VLoss min) (km/s) (m/s) .000 0.00000 0.0000				
HELIOCENTRIC TRANSFER ORBIT ELEMENTS								
(AU) 1.3825683 0.2	ntricity Inclination Asc N (deg) (deg 72295783 2.86875 348.42 33405452 0.32232 170.85	deg) (deg) (deg) 459 355.67973 4.32685	n True Anom Perihelio (deg) (AU) 5 144.98922 1.0061008	(AU) (days. 1.7590358 593.78375				
	LAUNCH DE	LTA V ORIENTATION - PLANETO	OCENTRIC					
Altito (km 800.0 800.0	) (deg) (km/sec) 0000 51.60000 1.36460	(deg) (deg)		0.23518				
		MISSION OPERATIONS						
	Earth Mars Dep Helio Arr	Earth Dep Helio Arr						
imes (days) Depart/Arrive Flight/Stay	0.00 200.00 512.0	712.00 912.00 0 200.00						
lsc/Cap Orbits (radii) Apoapse Distance Periapse Distance	12.09 0.00 1.13 0.00	10.95 0.00 1.07 0.00						
pacecraft Distances ( Minimum Heliocentric Maximum Heliocentric Geocentric	1.0067	0.9935 1.4573 1.4798 0.0000						
<pre>/aneuvers   Propulsion Type   Vinf (km/sec)   Eff Delta-V (km/sec)   Vel Losses (m/sec)   Propellant (kg or t)   Burn time (hr)   Thrust (lbs or klbs)   Spec Imp (sec)</pre>	Vloss None 4.31 3.68 1.36 0.00 0.00 56.93 0.00 30.90 0.00 0.00 0.35 0.00 24.75 0.00 463.4 0.0	Vloss None 3.84 6.26 1.57 0.00 0.00 15.41 0.00 15.76 0.00 0.00 0.17 0.00 24.75 0.00 442.1 0.0						

0.00 23.56 0.00 0.00 0.00

0.00 17.31 13.10 0.00 0.00

6.30

# PERFORMANCE SUMMARY

. in a contract dear			
त Stay Time Depar (days)	rt	Arrive Flight To	
Earth	n SEP 13, 2022, 12.0000 hours GMT Julian Date 59836.0000	Mars APR 1, 2023, 12.0000 hours GMT Un 200 Julian Date 60036.0000	r - a
. 509.9958 Mars	AUG 23, 2024, 11.9001 hours GMT Julian Date 60545.9958	Earth MAR 11, 2025, 11.9001 hours GMT 200.000 Julian Date 60745.9958	33
		Total Duration 909.395	5.9
	SPACECRAFT MASS SU		
Leg Initial Engine	Depart Arrive e Propell Tankage Engine Propell T	Tankage Thert Probes Melobik Drops Sumpres Heart	
1 119.497 6.000 2 51.823 6.300		0.000     0.000     17.312     13.100     0.000     0.000     51.6       0.000     0.000     23.558     0.000     0.000     0.000     6.3	
	DEPARTURE/ARRIVA		
Leg V Inf (km/s) (c 1 4.34547 4	Decl Rt Asc Brn Tm Del V VLoss deg) (deg) (min) (km/s) (m/s) 2.35 54.65 21.507 1.37824 58.925 0.42 29.07 10.347 1.57251 15.412	(km/s) (deg) (deg) (min) (km/s) m. 3.60710 -18.61 186.68 0.000 0.00000 3	. 188
	HELIOCENTRIC TRANSFE		
(AU) 1 3792178 0 271	ricity Inclination Asc Node Arg Per (deg) (deg) (deg) 435907 2.81381 350.37226 353.6020 405392 0.32232 170.85060 57.7174	(deg) (deg) (AU) (AU) d. (5) (deg) (	riod Mays: 62661 10709
	LAUNCH DELTA V ORIENTAT	TION - PLANETOCENTRIC	
Altitud (km) 800.000 800.000	(deg) (km/sec) (deg) 00 51.60000 1.37824 8.60769	Rt Ascension (deg)         X Dot (km/sec)         Y Dot (km/sec)         2 Dot (km/sec)           15.27520         1.31458         0.35902         0.20629           343.94129         0.88016         -0.25336         1.02990	
	MISSION OF	PERATIONS	
	Earth Mars Dep Helio Arr Dep Helio	Earth o Arr	
Times (days) Depart/Arrive Flight/Stay	0.00 200.00 710.00 200.00 510.00 200.00	910.00	
Esc/Cap Orbits (radii) Apoapse Distance Periapse Distance	12.09 0.00 10.95 1.13 0.00 1.07	0.00 0.00	
Spacecraft Distances (AU Minimum Heliocentric Maximum Heliocentric Geocentric	1.0062 0.9935 1.6487 1.4588 1.4798		
Maneuvers Propulsion Type Vinf (km/sec) Eff Delta-V (km/sec) Vel Losses (m/sec) Propellant (kg or t) Burn time (hr) Thrust (lbs or klbs) Spec Imp (sec)	Vloss None Vloss 4.35 3.61 3.84 1.38 0.00 0.00 1.57 0.00 58.92 0.00 15.41 31.26 0.00 0.00 15.76 0.00 0.36 0.00 0.17 24.75 0.00 24.75 463.4 0.0 442.1	0.00	
Mass Changes (kg or t) Dry Stage Jettisoned Probes Separated AeroBrake Separated Drop Mass Left Sample Mass Added	6.00 0.00 6.30 17.31 13.10 0.00 0.00	0.00 23.56 0.00 0.00 0.00	-

.. : (Converged)

# PERFORMANCE SUMMARY

: Stay Time Depa. (days)	rt	Arrive		Flight Time days
Eart		671 hours GMT Mars 59836.6695	APR 2, 2023, 4.0671 hour: Julian Date 60036	s GMT 200.0000
509.3264 Mars		000 hours GMT Earth 60545.9958	MAR 11, 2025, 11.9000 hour: Julian Date 60745	
	SPA	iou-do: C3 = 1 CECRAFT MASS SUMMARY (kg or 1	9	ation 309.3264
	Depart e Propell Tankage Eng		rt Probes AeroBrk Drops	Samples NetMass
1 119.656 6.000 2 51.823 6.300			00 17.312 13.100 0.000 00 23.558 0.000 0.000	
	O	EPARTURE/ARRIVAL CONDITIONS		
Leg V Inf I (km/s) (c 1 \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	2.00 54.01 21.617 1	Del V VLoss V Ir (km/s) (m/s) (km/s	s) (deg) (deg) (min) 69 -18.49 186.71 0.000	Del V VLoss (km/s) (m/s)
	HELIO	CENTRIC TRANSFER ORBIT ELEMEN	NTS	
Semi-Axis Eccentr (AU) 1 1.3780659 0.2711 1 1.1815417 0.2334		g) (deg) (deg) 2468 352.89782 7.10619	True Anom Perihelion Ap (deg) (AU) 146.36329 1.0043619 1.7	bhelion Period (AU) (days) 7517700 590.88563 1573199 469.10709
	LAUNCH DI	ELTA V ORIENTATION - PLANETOC	CENTRIC	
Altitude (km) 800.0000 800.0000	(deg) (km/sec) 00 51.60000 1.38432	Declination Rt Ascension (deg) (deg) 8.18158 15.02302 48.61476 343.62964		ec) 100
		MISSION OPERATIONS		
imes (days)	Earth Mars Dep Helio Arr	s Earth Dep Helio Arr		
Depart/Arrive Flight/Stay	0.00 200.00 200.00 509.3	709.33 909.33 33 200.00		
sc/Cap Orbits (radii) Apoapse Distance Periapse Distance	12.09	10.95 0.00 1.07 0.00		
pacecraft Distances (AU) Minimum Heliocentric Maximum Heliocentric Geocentric	1.0060 1.6490 0.0000 1.4654	0.9935 1.4573 1.4798 0.0000		
neuvers Propulsion Type Vinf (km/sec) Eff Delta-V (km/sec) Vel Losses (m/sec) Propellant (kg or t) Burn time (hr) Thrust (lbs or klbs) Spec Imp (sec)	Vloss None 4.36 3.58 1.38 0.00 0.00 59.83 0.00 31.42 0.00 0.00 0.36 0.00 24.75 0.00 463.4 0.0	Vloss None 3.84 6.26 1.57 0.00 0.00 15.41 0.00 15.76 0.00 0.00 0.17 0.00 24.75 0.00 442.1 0.0		
iss Changes (kg or t) Dry Stage Jettisoned Probes Separated AeroBrake Separated Drop Mass Left Sample Mass Added	6.00 0.00 17.3 13.1 0.0 0.0	0.00	,	

ase 1 (Converged) PERFORMANCE SUMMARY Flight Time Arrive leg Stay Time Depart days. (days) Mars MAY 5, 2025, 4.4291 hours GMT Julian Date 69900.6845 269.6845 Earth OCT 9, 2024, 12.0000 hours GMT Julian Date 60592.0000 Mars SEP 30, 2026, 10.5960 hours GMT Earth APR 18, 2027, 10.5960 hours GMT Julian Date 61313.9415 Julian Date 61513.9415 513.2570 Total Duration 321.3415 SPACECRAFT MASS SUMMARY (kg or t) ------ Depart ------ Arrive ------Initial Engine Propell Tankage Engine Propell Tankage Inert Probes AeroBrk Drops Samples NetMass Leq 118.695 6.000 30.590 0.000 0.000 0.000 0.000 17.312 13.100 0.000 0.000 51.693 51.693 6.300 15.635 0.000 0.000 0.000 0.000 0.000 23.558 0.000 0.000 0.000 6.200 DEPARTURE/ARRIVAL CONDITIONS ----- Arrive ----- Depart -----V Inf Decl Rt Asc Brn Tm Del V VLoss (km/s) (deg) (deg) (min) 1km/s: m/s: 4.82626 -29.11 232.32 0.000 0.00000 0.0000 0.0000 -1.78 11.02 0.000 0.00000 0.0000 V Inf Decl Rt Asc Brn Tm Del V VLoss (km/s) (deg) (deg) (min) (km/s) (m/s) (4.29200) 48.90 108.57 21.045 1.35434 55.296 3.82106 15.24 49.80 10.262 1.56167 15.033 Leg HELIOCENTRIC TRANSFER ORBIT ELEMENTS

Leg	Semi-Axis	Eccentricity	Inclination (deg)	Asc Node (deg)	Arg Per (deg)	True Anom (deg)	(deg)	Perihelion (AU)	(AU)	Period (days.
1	1.3868010	0.279785537	3.23528	15.38136		357.28155	146.01688		1.7748078	596.51260
2	1.2361880	0.260104758	1.27868	27.87954	235.25057	181.89730	304.67056	0.9146496	1.5577263	502.02490

#### LAUNCH DELTA V ORIENTATION - PLANETOCENTRIC

Altitude	Inclination (deg)	Delta V (km/sec)	Declination (deg)	Rt Ascension (deg)	X Dot (km/sec)	Y Dot (km/sec)	<pre>Z Dot (km/sec)</pre>
(km) 800.00000	51.60000	1.35434	19.64712	59.68520	0.64381	1.10109	0.45536
800.00000	51.60000	1.35434	41.23676	37.90962	0.80354	0.62576	0.89274

#### MISSION OPERATIONS

	Earth			Mars		Earth
	Dep	Helio	Arr	Dep	Helio	Arr
Times (days)						
Depart/Arrive	0.00			721.94		921.94
Flight/Stay		208.68	:	513.26	200.00	
Esc/Cap Orbits (radii)						
Apoapse Distance	12.09		0.00			0.00
Periapse Distance	1.13		0.00	1.07		0.00
Spacecraft Distances (AU)						
Minimum Heliocentric		0.9988			1.0040	
Maximum Heliocentric		1.6644			1.5574	
Geocentric	0.0000		1.4604	1.6690		0.0000
Maneuvers						
Propulsion Type	Vloss		None			None
Vinf (km/sec)	4.29		4.83			6.81
Eff Delta-V (km/sec)	1.35	0.00	0.00			
Vel Losses (m/sec)	55.30		0.00			0.00
Propellant (kg or t)	30.59	0.00	0.00	15.64	0.00	
Burn time (hr)	0.35		0.00			0.00
Thrust (lbs or klbs)	24.75		0.00	24.75		0.00
Spec Imp (sec)	463.4		0.0	442.1		0.0
Mass Changes (kg or t)						
Dry Stage Jettisoned	6.00		0.00			0.00
Probes Separated				17.31		23.56
AeroBrake Separated				13.10		0.00
Drop Mass Left				0.00		0.00
Sample Mass Added				0.00		0.00
•						

Mass Changes (kg or t)
Dry Stage Jettisoned
Probes Separated
AeroBrake Separated
Drop Mass Left
Sample Mass Added

# PERFORMANCE SUMMARY

33000 32 4 320								
eg Stay Time Depart (days:		Arrive		F1lgrt Time dayar				
: £arth	OCT 10, 2024, 12.000 Julian Date		MAY 2, 2025, 11.18 Julian Date	37 hours GMT 203.9660 60797.9660				
. 515.9755 Mars	SEP 30, 2026, 10.595 Julian Date	5 hours GMT	APR 18, 2027, 10.59 Julian Date	55 hours GMT 200.0000 61513.9415				
			Та	tal Duration 91%, +416				
	SDACE	CRAFT MASS SUMMARY (kg or	<b>†</b> 1					
	Depart							
Leg Initial Engine	Propell Tankage Engin	e Propell Tankage In	ert Probes AeroBrk	Drops Samples NetMass				
	30.590 0.000 0.00 15.635 0.000 0.00		000 17.312 13.100 000 23.558 0.000	0.000 0.000 51.693 0.000 0.000 6.233				
	DEP	ARTURE/ARRIVAL CONDITIONS						
	Depart			Brn Tm Del V VLoss				
$\frac{(km/s)}{4.29200} = (de)$	g) (deg) (min) (k 98 107.40 21.045 1.3	m/s) (m/s) (km 5434 55.296 4.98	Inf Decl Rt Asc (/s) (deg) (deg) 228 -27.84 232.67 300 -1.78 11.02	(min) (km/s) 'm/s' 0.000 0.00000 0.000				
2 3.82106 15.	24 49.80 10.262 1.5	6167 15.033 (6.81	300] -1.78 11.02	0.000 0.00000 3.000				
	HELIOCENTRIC TRANSFER ORBIT ELEMENTS							
Comi Avia Pagantri	city Inclination Asc No	Departur de Arg-Per True-Ano		ion Aphelion Period				
(AU) 1 1 3937281 0 28364	(deg) (deg) 2741 2.99740 17.360	(deg) (deg) 82 1.30228 358.6740	(deg) (AU) 3 144.24864 0.99840	(AU) (days) 072 1.7890490 600.98760				
2 1.2361879 0.26010	1.27868 27.879	54 235.25056 181.8972	9 304.67055 0.91464	196 1.5577262 502.02478				
	LAUNCH DEL	TA V ORIENTATION - PLANET	OCENTRIC					
Altitude (km)	Inclination Delta V (deq) (km/sec)	Declination Rt Ascensio (deg) (deg)	(km/sec) (km/sec)	(km/sec)				
800.00000 800.00000	51.60000 1.35434	15.71553 62.15622 44.01033 35.50621	0.60892 1.15277	0.36684 0.94098				
		MISSION OPERATIONS						
	Earth Mars							
Times (days)	Dep Helio Arr	Dep Helio Arr						
Depart/Arrive Flight/Stay	0.00 203.97 203.97 515.98							
Esc/Cap Orbits (radii) Apoapse Distance	12.09 0.00							
Periapse Distance	1.13 0.00	1.07 0.00						
Spacecraft Distances (AU) Minimum Heliocentric	0.9984	1.0040						
Maximum Heliocentric Geocentric	1.6648 0.0000 1.4354	1.5574 1.6690 0.0000						
Maneuvers Propulsion Type	Vloss None	Vloss None						
Vinf (km/sec) Eff Delta-V (km/sec)	4.29 4.98 1.35 0.00 0.00	3.82 6.81 1.56 0.00 0.00						
Vel Losses (m/sec) Propellant (kg or t)	55.30	15.03 0.00 15.64 0.00 0.00						
Burn time (hr) Thrust (lbs or klbs)	0.35 0.00 24.75 0.00	0.17 0.00 24.75 0.00						
Spec Imp (sec)	463.4 0.0	442.1 0.0						

0.00 23.56 0.00 0.00 0.00

17.31 13.10 0.00 0.00

6.30

0.00

Mass Changes (kg or t) Dry Stage Jettisoned Probes Separated AeroBrake Separated Drop Mass Left Sample Mass Added

6.00

# PERFORMANCE SUMMARY

n l (Converged)		PERFORMANCE	SUMMARY				
~; Stay Time De (daγs)	part		Arrive	Flight Tis Edays	Ti-P		
•		12.0000 hours GMT Date 60596.0000	Mars MAY 2, 20	25, 0.4686 hours GMT 201.319 Lan Date 60797.8198	'n		
. 516.4219 <b>Ma</b>	rs SEP 30, 2026,	10.5950 hours GMT Date 61313.9415	Earth APR 18, 20	027, 10.5950 hours GMT 200.100 ian Date 61513.9415	3		
	54114	, , , , , , , , , , , , , , , , , , ,		Total Duration 917.941	5		
		SPACECRAFT MASS SUM	MARY (kg or t)				
	Depart	Arrive Engine Propell Ta	inkage Inert Probes	AeroBrk Drops Samples NetMa	\$ S		
1 118.695 6.	000 30.590 0.000 300 15.635 0.000	0.000 0.000	0.000 0.000 17.312 0.000 0.000 23.558	13.100 0.000 0.000 51.6 0.000 0.000 0.000 6.2			
2 51.693 6.	300 13.033 0.000	DEPARTURE/ARRIVAL					
	P	_		Arrive			
Leg V Inf	Decl Rt Asc Brn Tm (deg) (deg) (min)	Del V VLoss	V Inf Decl	Rt Asc Brn Tm Del V VLo (deg) (min) (km/s, m. 232.99 0.000 0.00000 0.0	55 5 00		
1 4.29200 2 3.82106	15.24 49.80 10.262		6.81300 -1.78	11.02 0.000 0.00000 3.3	53		
HELIOCENTRIC TRANSFER ORBIT ELEMENTS							
Leg Semi-Axis Ecce (AU) 1 1.3952564 0.2 2 1.2361878 0.2	84799605 2.84632	Asc Node Arg Per (deg) (deg) 19.34228 359.53967 27.87954 235.25055	0.43332 143.83732	(AU) (AU) (da	ys: 7640		
	LAUN	CH DELTA V ORIENTATI	ON - PLANETOCENTRIC				
Altit			Rt Ascension X Dot	Y Dot Z Dot			
(km 800.0 800.0	00000 51.60000 1.3	sec) (deg) 5434 13.73068 5434 45.27230	(deg) (km/sec) 61.88002 0.62009 33.35667 0.79609	(km/sec) (km/sec) 1.16034 0.32146 0.52406 0.96220			
		MISSION OPE	ERATIONS				
	Earth Dep Helio Arr	Mars Dep Helio	Earth Arr				
Times (days) Depart/Arrive Flight/Stay	0.00 201.52	717.94 516.42 200.00	917.94				
Esc/Cap Orbits (radii)	12.09 0.00	10.95	0.00				
Apoapse Distance Periapse Distance	1.13		0.00				
Spacecraft Distances Minimum Heliocentric Maximum Heliocentric Geocentric	0.9979	1.0040 1.5574 1.6690	0.0000				
Maneuvers Propulsion Type Vinf (km/sec) Eff Delta-V (km/sec) Vel Losses (m/sec) Propellant (kg or t) Burn time (hr) Thrust (lbs or klbs) Spec Imp (sec)	55.30 0.00 30.59 0.00 0.00 0.35 0.00	3.82 1.56 0.00 15.03 15.64 0.00 0.17 24.75	None 6.81 0.00 0.00 0.00 0.00 0.00 0.00				

0.00 23.56 0.00 0.00 0.00

0.00 6.30 17.31 13.10 0.00 0.00

PERFORMANCE SUMMARY

roe . (Converged)		PERFURMANCE SUMMART					
ঞৰ Stay Time Depart (days)		Arrive		Flight Time (days)			
1 Earth	OCT 14, 2024, 12.0000 Julian Date 6		MAY 3, 2025, 8.0684 hos: Julian Date 6079				
515.1053 <b>Mars</b>	SEP 30, 2026, 10.5946 Julian Date 6		APR 18, 2027, 10.5946 hou: Julian Date 6151				
			Total Du	ration 915.9414			
	SPACECE	NAFT MASS SUMMARY (kg or	t)				
	Depart Propell Tankage Engine		ert Probes AeroBrk Drop:	s Samples NetMass			
	30.590 0.000 0.000 15.635 0.000 0.000		000 17.312 13.100 0.000 000 23.558 0.000 0.000				
	DEPAR	RTURE/ARRIVAL CONDITIONS					
	Depart		Arrive				
	cl Rt Asc Brn Tm Del	. V VLoss V I	Inf Decl Rt Asc Brn Tm	Del V VLoss			
(km/s) (de $4.29200$ ) 45.		(s) (m/s) (km/  34 55.296 4.964	(s) (deg) (deg) (min) 171 -26.65 233.31 0.000	(km/s) m/s" 0.00000 0.000			
2 3.82106 15.				0.00000 0.000			
	HELIOCENT	RIC TRANSFER ORBIT ELEME	INTS				
Comi Buin Barabai	city Inclination Asc Node		e Arrival n True Anom Perihelion A	Aphelion Period			
Leg Semi-Axis Eccentri (AU)	(deg) (deg)	(deg) (deg)	(deg) (AU)	(AU) daysi			
1 1.3921562 0.28376 2 1.2361878 0.26010		. 357.45764 2.51223 235.25054 181.89727	3 144.51343 0.9971125 1. 7 304.67053 0.9146495 1.	.7871999 599.97114 .5577260 502.02469			
LAUNCH DELTA V ORIENTATION - PLANETOCENTRIC							
Altitude Inclination Delta V Declination Rt Ascension X Dot Y Dot Z Dot							
(km) 800.00000	(deg) (km/sec)	(deg) (deg)	(km/sec) (km/sec) (km/s 0.65760 1.14660 0.29	sec) 9514			
800.00000			0.80925 0.48131 0.95	7349			
		MISSION OPERATIONS					
	Earth Mars	Earth					
Times (days)		Dep Helio Arr					
Depart/ <b>Arrive</b>	0.00 200.84 71 200.84 515.11	5.94 915.94 200.00					
Flight/Stay	200.64 313.11	200.00					
Esc/Cap Orbits (radii) Apoapse Distance	12.09 0.00 1	0.95 0.00					
Periapse Distance	1.13 0.00	1.07 0.00					
Spacecraft Distances (AU) Minimum Heliocentric	0.9973	1.0040					
Maximum Heliocentric	1.6647	1.5574					
Geocentric	0.0000 1.4434 1.	6690 0.0000					
Maneuvers Propulsion Type	Vloss None V	loss None					
Vinf (km/sec)	4.29 4.96	3.82 6.81					
Eff Delta-V (km/sec) Vel Losses (m/sec)		1.56 0.00 0.00 5.03 0.00					
Propellant (kg or t)	30.59 0.00 0.00 1	5.64 0.00 0.00 0.17 0.00					
Burn time (hr) Thrust (lbs or klbs)	24.75 0.00 2	4.75 0.00					
Spec Imp (sec)	463.4 0.0 4	42.1 0.0					
Mass Changes (kg or t)	6.00 0.00	6.30 0.00					
Dry Stage Jettisoned Probes Separated	17.31	23.56					
AeroBrake Separated Drop Mass Left	13.10 0.00	0.00 0.00	•				
Sample Mass Added	0.00	0.00					

.e 1 (Converged)

# PERFORMANCE SUMMARY

PERFORMANCE SUMMARY									
.н: Stay Time Deg	part		Arr	ive		Flight Time dayo			
i Ea		2024, 12.0000 hou ulian Date 6060		s MAY ε, ζ Ju	1025, 22.6385 hours Hian Date - 60802.	3 GMT   010.4433 .4433			
_ 511.4982 <b>Ma</b> :		2026, 10.5941 hou ulian Date 6131			2027, 10.5941 hours Hian Date 61513.				
					Total Dura	ation 913.9414			
		SPACECRAFT	MASS SUMMARY (	kg or t)					
Leg Initial Eng:	Depart ine Propell Tank	age Engine Pr	rive	Inert Probes	AeroBrk Drops	Samples NetMass			
			0.000 0.000 0.000 0.000	0.000 17.312 0.000 23.558	13.100 0.000 0.000 0.000				
DEPARTURE/ARRIVAL CONDITIONS									
	Depar	t			Arrive				
Leg V Inf (km/s)	Decl Rt Asc (deg) (deg)	Brn Tm Del V (min) (km/s)	VLoss (m/s)	V Inf Decl (km/s) (deg)	(deg) (min)	(km/s: [m/s:			
1 4.29200	44,84 99.34	21.045 1.35434 10.262 1.56167	55.296	4.78347 -26.48 6.81300 -1.78	233.63 0.000 11.02 0.000	0.00000 0.000 0.00000 0.000			
		HELIOCENTRIC	TRANSFER ORBIT	ELEMENTS					
ing Comi-Avic Eccor	ntricity Inclinat	ion Asc Node		arture Arrival	n Perihelion Ap	ohelion Perica			
Leg Semi-Axis Eccer (AU) 1 1.3834420 0.28	(deg)	(ded)	(dea) (	dea) (dea)		(AU) (days)			
	60104676 1.278		235.25053 181	.89726 304.67053	0.9146495 1.5	5577259 500.00465			
		LAUNCH DELTA V	ORIENTATION - P	LANETOCENTRIC					
Altitu (km)	(deg)	(km/sec) (	'dea) (d	ension X Dot	Y Dot Z Do (km/sec) (km/se	ec)			
800.00 800.00	51.60000	1.35434 12	2.05664 57.	06835 0.72003 27353 0.83227	1.11165 0.282 0.42908 0.978	289			
		MI	SSION OPERATION	S					
	Earth Dep Helio	Mars Arr Dep	Earth Helio Arr						
<pre>Times (days)   Depart/Arrive   Flight/Stay</pre>		202.44 713.9 511.50							
Esc/Cap Orbits (radii)									
Apoapse Distance Periapse Distance	12.09 1.13	0.00 10.9 0.00 1.0							
Spacecraft Distances (A			1.0040						
Maximum Heliocentric Geocentric	1.6640 0.0000	1.4764 1.669	1.5574						
Maneuvers Propulsion Type	Vloss	None Vlos	s None						
Vinf (km/sec) Eff Delta-V (km/sec)	4.29 1.35 0.00	4.78 3.8 0.00 1.5	6.81						
Vel Losses (m/sec) Propellant (kg or t)	55.30 30.59 0.00	0.00 15.0 0.00 15.6	0.00						
Burn time (hr) Thrust (lbs or klbs)	0.35 24.75	0.00 0.1 0.00 24.7	7 0.00						
Spec Imp (sec)	463.4	0.0 442.							
Mass Changes (kg or t) Dry Stage Jettisoned	6.00	0.00 6.3	0.00						
Probes Separated AeroBrake Separated		17.31 13.10	23.56 0.00						
Drop Mass Left Sample Mass Added		0.00 0.00	0.00 0.00						
<del>-</del>									

### 1 (Converged) PERFORMANCE SUMMARY															
⊹⊈ Stay (d	Time ays)	Depar	t						Ari	rive				₽.	Lipin Dine dayo
		Earth	(	OCT 19,		12.000 Date			Mar	s	MAY 15,	2025, 13.8 Ulian Date	983 nour: 60811	s GMT .0791	204.0791
502	.8623	Mars	:	SEP 30,		10.593 Date			Ear	th	APR 18,	2027, 10.5 Ulian Date	936 hour: 61513	s GMT	<u> </u>
												T	otal Dura	ation	311.9414
						SPACE	CRAFT	MASS SU	JMMARY (	kg or t)					
Leg I	nitial	Engine	- Depar Prope	t ll Tan)	cage	Engin	Arr ne Pro	ive pell T	Tankage	Inert	Probes	AeroBrk	Drops	Samples	NetMass
	18.695 51.693	6.000 6.300	30.5 15.6	90 0. 35 0.	.000	0.00	00 0	0.000	0.000			13.100 0.000	0.000 0.000	0.000 0. <b>0</b> 00	51.693 6.000
DEPARTURE/ARRIVAL CONDITIONS															
Leg 1 2	V 1k1 4.2	Inf Dem/s) (de 9200 45 2106 15	ecl R eg) .10	Asc	Brn Tm (min) 21.045	n D   (k   1.3	el V m/s) 15434	VLoss (m/s) 55.296	; ;	V Inf (km/s) 4.35801	Decl (deg) -26.85	Arri Rt Asc (deg) 233.76 11.02	Brn Tm (min) 0.000	Del V (km/s: 0.00000	VLoss (m/s) 0.000
	HELIOCENTRIC TRANSFER ORBIT ELEMENTS														
1 1.	(AU) 3650918	0.2718 0.2601	- 65766	(deg)	347	(deg) 25.298	103 3	Arg Per (deg) (51.6775	Tru (3	e Anom deg) .28769	(deg) 151.6836	m Perihe (AU 7 0.9939 2 0.9146	) 701 1.1	(AU) 7362135	
					LAUN	NCH DEL	TA V O	RIENTAT	CION - F	LANETOCE	INTRIC				
		Altitude (km) 800.00000 800.00000	5:	linatior (deg) 1.60000 1.60000	(km/ 1.3	(sec) 35434	(d 12.	leg)	(d 51.		0.82234	(km/sec) 1.03562	(km/se	ec) 238	
MISSION OPERATIONS															
			Earth Dep		Arr	Mars	Dep	Helic	Earth Arr						
imes (day Depart/ Flight/	Arrive		0.00	209.08		) 502.86			911.94						
зс/Сар О: Apoapse Periapse	Distan	ce	12.09 1.13		0.00		10.95		0.00						
pacecraft Minimum Maximum Geocenti	Helioc Helioc		0.0000	0.9962 1.6620	1.5541	l	1.6690	1.0040							
Propuls: Vinf (kr Eff Delt Vel Loss Propella Burn tim Thrust Spec Imp	ion Type m/sec} ta-V (kr ses (m/s ant (kg me (hr) (lbs or	m/sec) sec) or t)	Vloss 4.29 1.35 55.30 30.59 0.35 24.75 463.4		None 4.36 0.00 0.00 0.00 0.00	5 ) ) )	Vloss 3.82 1.56 15.03 15.64 0.17 24.75 442.1	0.00	0.00						

0.00 23.56

0.00

0.00 17.31 13.10 0.00 0.00

0.00

6.30

6.00

'ass Changes (kg or t)
Dry Stage Jettisoned
Probes Separated
AeroBrake Separated
Drop Mass Left

Sample Mass Added

# REPORT DOCUMENTATION PAGE

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	October 7, 199	9   <b>Ma</b> y 7, 19	999 to Sept 30, 1999				
4. TITLE AND SUBTITLE	FUNDING NUMBERS						
Human Mars Mission St	udy Support						
"Launch Window from E							
6. AUTHORS	H-28653D						
Archie Young	(Part I)						
7 <b></b>							
7. PERFORMING ORGANIZATION	PERFORMING ORGANIZATION						
Alpha Technology, Ir		REPORT NUMBER					
3322 South Memoria		None					
		None					
Huntsville, AL 35801							
9. SPONSORING/MONITORING	AGENCY NAME(S) AND ADDRES	SS(ES) 10	. SPONSORING/MONITORING AGENCY				
			REPORT NUMBER				
NASA/MSFC TD31/	Mr. Larry Kos						
MSFC, AL 35812							
14161 6, 712 666 12							
11. SUPPLEMENTARY NOTES							
Final Report F	Required by the Contrac	ot.					
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13. ABSTRACT (Maximum 200 wo	rds)						
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OF REPORT	OF REPORT						
Unclassified None None							